SCIENCE

NEW SERIES
VOL. LXX, No. 1808

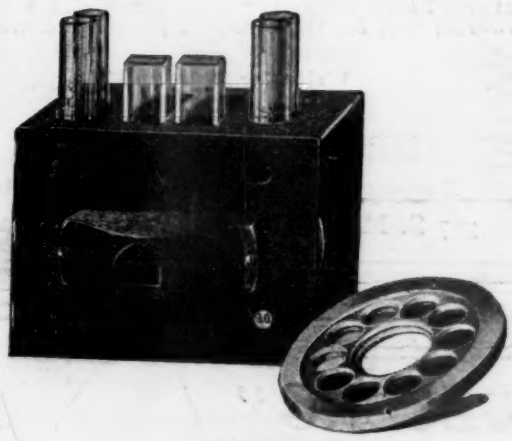
FRIDAY, AUGUST 23, 1929

ANNUAL SUBSCRIPTION, $6.00
SINGLE COPIES, 15 CTS.

HYDROGEN ION APPARATUS

HELLIGE COLORIMETRIC COMPARATORS

Employ Permanent Non-Fading Glass Standards



18004

DEPENDENCE on standard color solutions which are apt to change more or less in the course of time is avoided. The glass standards are arranged in circular discs, each having 8 to 10 standard plates for a given indicator matching the pH value in steps of 0.2 pH.

Price of outfit as per cut, including 1 disc and 1 indicator solution **$35.00**

The Hellige Pocket Comparator is a smaller outfit, using the same color discs but not including prism and acid proof glass cells; test tubes being used instead of the square cells **$17.50**

For water works the color scale of the Chlorine test is recommended.

Write for Bulletin No. 406 and additional details.

EIMER & AMEND

Established 1851, Incorporated 1897

Headquarters for LABORATORY APPARATUS and CHEMICAL REAGENTS

We have no agents. To be sure of E.&A. material order direct.

NEW YORK, N. Y.
Third Ave., 18th to 19th St.

Entered as second-class matter July 18, 1923, at the Post Office at Lancaster, Pa., under the Act of March 3, 1879.

Parasitic Worms

By OWEN L. WILLIAMS

Mr. Owen L. Williams, Teaching Fellow in Zoology at the University of California, has found several new forms of the worm, Genus *Acuaria*—the first species to be recorded from North America. This paper is entitled:

A Critical Analysis of the Specific Characters of the Genus Acuaria, Nematodes of Birds, with Description of New American Species.

Well illustrated; 50 cents postpaid

Mr. Leslie M. Smith, also on the Staff of the Department of Zoology, has discovered a new worm in three species of "Jerusalem crickets." The new genus and species is described under the title:

Coccospora Stenopelmati Gen. Nov., Sp. Nov. A Gregarine from Stenopelmatus (Orthoptera) from Central California.

Illustrated; 25 cents

Berkeley, California

University of California Press

Berkeley, California

PHOTO-ELECTRIC CELLS

THE BURT CELL

Without Fatigue—Highly Sensitive
Absolutely Reproducible—Instantaneous in Response

The **BURT-CELL** is made by a new method and should not be confused with any other photo-electric cell. By a special process of electrolysis, the photo-electric metal is introduced into a highly evacuated bulb directly through the glass wall of the bulb, giving photo-electric material of absolute purity. The superiority of the **BURT-CELL** is due to these features, making possible results never before obtainable.

Described in Bulletin No. 271

QUARTZ CELLS—We are pleased to announce that we are manufacturing reproducible quartz photo-cells for measurement of ultra-violet.

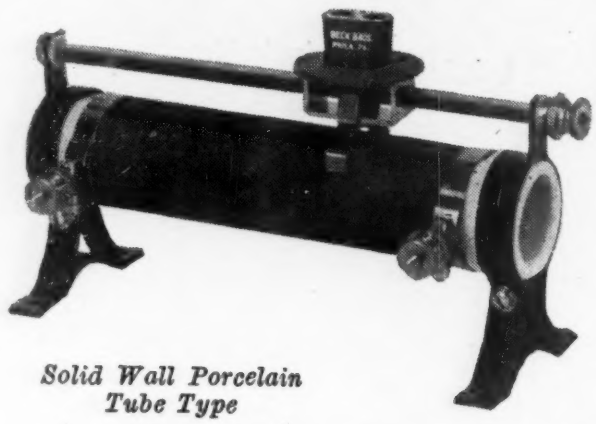
We also manufacture the **STABILIZED OSCILLOSCOPE**—the only **VISUAL OSCILLOGRAPH** having a linear time axis and no inertia—giving an accurate picture of high frequency wave forms. This is a most powerful tool for the study of periodic phenomena.

Write for Bulletin 273

DR. ROBERT C. BURT

Manufacturing and Consulting Physicist

327 S. Michigan Ave., Pasadena, Calif.



Solid Wall Porcelain Tube Type

"BECBRO" LABORATORY RHEOSTATS

Becbro Laboratory Rheostats made of both iron enameled and solid wall porcelain tubes.

The above illustration shows one of the numerous types of "BECBRO" tubular, slide contact, rheostats manufactured and carried in stock by us.

The various types are made in several lengths of 8", 16", and 20", respectively, with resistance values of from 0.25 ohm and 25 amperes, to 30,000 ohms and current capacity of 0.1 ampere.

"BECBRO" Rheostats are high in quality and low in price, and due to the fact that they are giving excellent service, will be found in many of the Colleges, Universities, Research Laboratories and Commercial stations throughout the country and world.

"BECBRO" Stone Rheostats are made in the following types: Single, Double, Universal, and Crossed Sections. These rheostats, with the porcelain tubular types, find their many uses in high frequency and radio work.

Our Catalogue S-20 Sent You Upon Request

BECK BROTHERS, *Makers*

421 SEDGLEY AVENUE **PHILADELPHIA, PA.**

The L & N Quinhydrone pH Indicator

Measurements Unaffected by Color

HERE is a pH Indicator that is not affected by color or turbidity and is more accurate than a color indicator. It can be used by practically anyone. It employs a quinhydrone electrode—a simple and economical type. Its range is 1 to 8.5 pH. It is accurate to within 0.04 pH, and is sensitive to changes of 0.01 pH. Complete directions are sent with each instrument. Specially purified chemicals and various types of Calomel electrodes are listed in Catalog S-75 which will be sent on request.

7654 Quinhydrone pH Indicator $65.00

Ask For Catalog S-75

LEEDS & NORTHRUP COMPANY
4901 STENTON AVENUE PHILADELPHIA, PA.

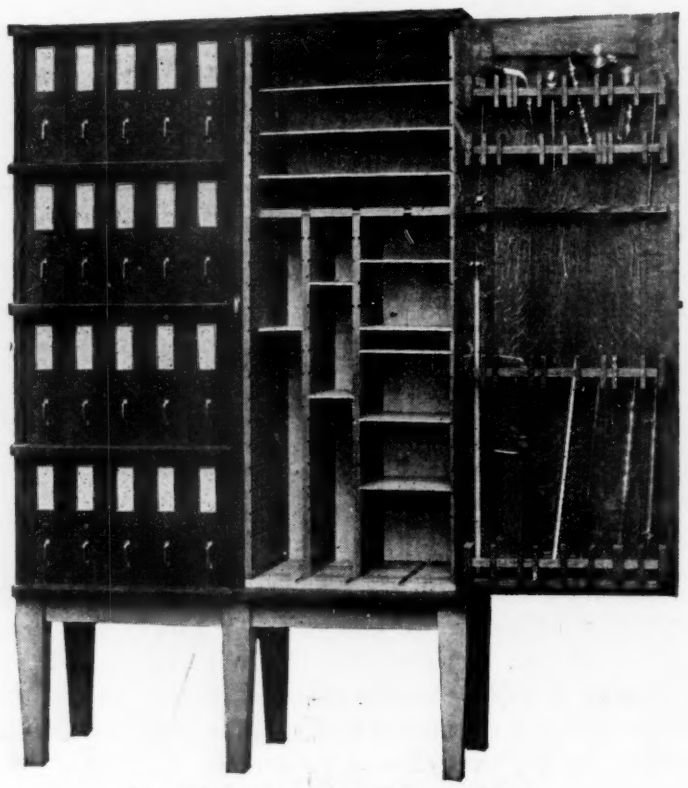
LEEDS & NORTHRUP

Electrical Measuring Instruments
Potentiometer Pyrometers
Hump and Homo Heat Treating Furnaces
Automatic Combustion Control

G-144

FILES YOUR APPARATUS AS WELL AS YOUR RE-AGENTS AND SUPPLIES

You can now file your laboratory supplies and apparatus in a most approved manner, keeping them in the best of condition, avoiding breakage and having the item you want right at your finger tips. The Schwartz Sectional System is to the laboratory what the Modern Letter File is to the Busy Office. The interior of the Apparatus & Instrument Unit Cabinet is adjustable for your various sized apparatus and instruments like the drawers in Standard Unit Chemical Cabinet, which accommodate containers from small vials to large bottles or cartons.



The Apparatus and Instrument Unit Cabinet, with door shown open, (right) and the Standard Unit Chemical Cabinet (left) with sanitary leg base.

Pat. Jan. 11, 1910. May 17, 1921

Schwartz Cabinets are made to match the color of your other furniture and in size to suit the needs of the smallest or the largest laboratories.

Write for Booklet "S" containing illustrations and Net Prices

SCHWARTZ SECTIONAL SYSTEM

INDIANAPOLIS, INDIANA

New Facilities For

MEASUREMENT OF TIME

The CENCO IMPULSE COUNTER (No. F789) is an entirely new laboratory instrument which makes possible another order of accuracy in the measurement of relatively short time intervals. It will count electrical impulses of frequencies up to 125 per second with an accuracy of 0.1 second.

Used with CENCO SPARK TIMER No. F787 (below), it permits an accurate time record by spark recording. The SPARK TIMER is a variable frequency spark controller transmitting intermittent spark impulses of any period from .035 seconds to 0.4 seconds as desired.

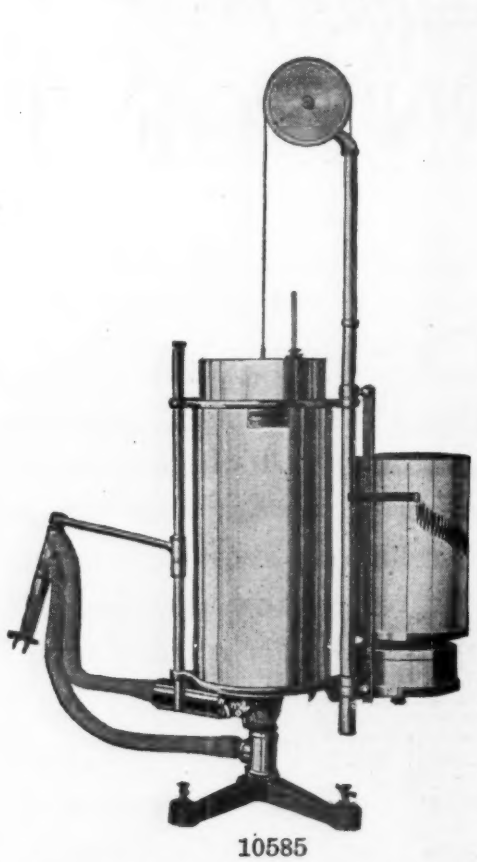
These two instruments together, in addition to hundreds of applications for increasing the precision of time measurement, allow the first practical and accurate use of spark timing in experiments on velocities and accelerations.

Spark timing has been applied to many standard physics measurements formerly dependent upon the tuning fork and similar confusing and inaccurate devices.

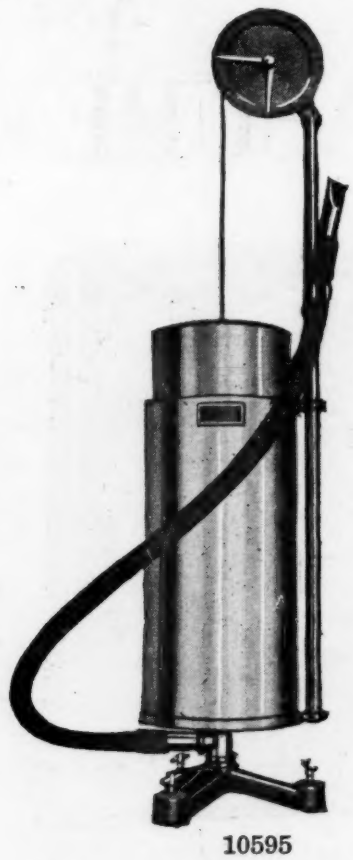
New catalog F will give you a complete story of what is being done in this field. Ask for your copy.

CENTRAL SCIENTIFIC COMPANY
LABORATORY Apparatus TRADE MARK CENCO REG. U.S. PAT. OFF. SUPPLIES Chemicals
460 E. Ohio St. Chicago U. S. A.

Metabolism Apparatus



10585



10595

10585 **METABOLISM APPARATUS—Benedict-Roth.** The Benedict-Roth Recording Metabolism Apparatus is a modification of the original Benedict Portable Metabolism Apparatus first developed at the Carnegie Nutrition Laboratory in Boston. The modifications, consisting in the substitution of Sadd respiratory valves for the original electric air impeller, were made by Dr. Paul Roth, of the Battle Creek Sanitarium. The apparatus together with the modifications, method of making tests and computations and the computation tables were reported in the *Boston Medical and Surgical Journal of April 6 and 13, 1922.* In this same journal of October 18, 1923, the apparatus was reported as being 99.81% accurate on the basis of alcohol check tests.

The Basal Metabolism is estimated by measuring the amount of oxygen that a patient consumes in a given time. This measurement of the oxygen consumption is simplified by the Kymograph which gives a graphic record of every respiration. The graphic record shows all details of the test—the amount of oxygen consumed and the duration of the test period. From it all the computations are made without taking readings of any kind.

The Benedict-Roth Metabolism Apparatus comes complete with all necessaries except barometer and oxygen..... **200.00**

10595 **VITAL CAPACITY SPIROMETER—Collins.** For use in measuring accurately the capacity of the lungs. It consists essentially of a bell, delicately compensated, floating in a cylinder filled with water. It has a direct reading dial graduated to tenths of liters with movable pointer stopping at the highest point to which the expiration has caused it to travel. A second pointer is provided to correct for slight inspirations from the spirometer just before expiring into it. No nose-clip is necessary. The apparatus is calibrated very exactly and the breathing tube is ample in diameter to prevent resistance to the expiration. The spirometer is made of non-corrodible metals, copper, brass, and aluminum and has a capacity of 6½ liters. It is finished in highly polished nickel-plate and supplied complete with breathing tube, two sterilizable nickel-plated mouth pieces and a simple chart for determining the body surface in square meters from the height and weight..... **50.00**

WILL CORPORATION

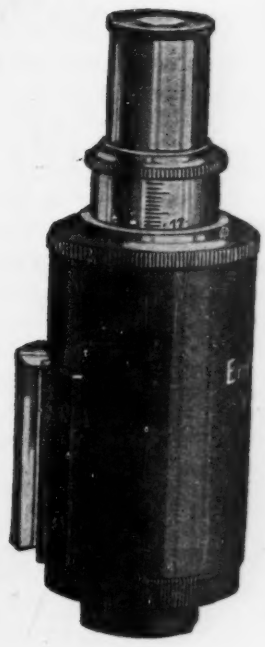
LABORATORY APPARATUS AND CHEMICALS
FOR
CHEMICAL, BIOLOGICAL, METALLURGICAL AND CLINICAL LABORATORIES

ROCHESTER, N.Y.

LEITZ
New Research Microscope
Model "ABMT"

Combination Type for Monocular and Binocular Vision as well as Photomicrography

Its particular feature focusses in the Built-In Mechanical Stage of square pattern; made of metal, it is completely covered with vulcanite and measures 120 x 120 mm.



The sideward motion is controlled by a worm screw drive, the backward and forward motion by rack and pinion. The screw heads are located at the right hand side and do not obstruct the stage proper.

Removing the arms holding the slide converts the stage to a plain surface with complete mechanical motions. Each movement is provided with scales divided in millimeters and verniers facilitate reorientation of specimens.

To appropriately equip Microscope "ABMT", we offer for selection an assortment of eight Apochromatic Objectives and nine Periplan (Compensating) Oculars.

WRITE FOR PAMPHLET NO. 1141 (O)

E. LEITZ, Inc.

60 East 10th Street **New York, N. Y.**

AGENTS:

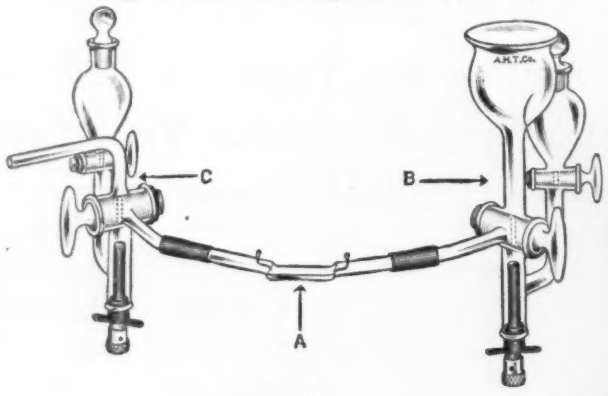
Pacific Coast States: SPINDLER & SAUPPE, Offices at San Francisco and Los Angeles, Calif.
Canada: THE J. F. HARTZ CO., Ltd., Toronto 2, Can.
Washington District: E. LEITZ, Inc., Investment Bldg., Washington, D. C.
Cuba: ANTIGA & CO., Havana, Cuba
Philippine Ids.: BOTICA DE SANTA CRUZ, Manila, P. I.

NORTHROP—KUNITZ

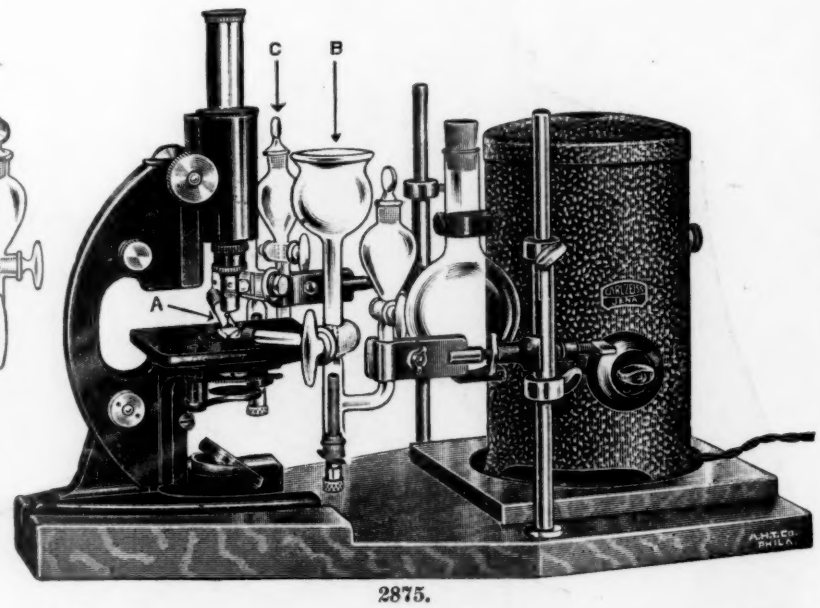
CATAPHORESIS APPARATUS

With assembly of accessory apparatus as suggested by Dr. Stuart Mudd

2873-A
Enlarged view of Cataphoresis Cell "A"



2873.



2875.

CATAPHORESIS APPARATUS, Northrop-Kunitz. As further modified by Dr. Kunitz, this apparatus is designed for measurement of the absolute migration velocity in a known potential gradient of suspensions of living cells or of the particles in colloidal dispersions or emulsions. Estimation from cataphoresis data of the surface electrical potential difference of particles is one of the important methods of colloid chemistry. It has proved valuable in the investigation of the theory of colloidal behavior and the action of emulsifying agents, in the study of the mechanism of immune reactions, in the determination of the correlation between the virulence and other characteristics of bacteria and their cataphoretic velocity, as a means of serological differentiation, and in other physical-chemical and biological problems.

The particles are observed with a microscope in a cataphoresis cell. This cell, which is the essential part of the apparatus, consists of two thin microscope slides separated by narrow strips of glass of uniform thickness. Glass tubes with electrical connections are fused into the two ends of this cell to provide for accurate calibration of the potential gradient.

		Code Word
2873.	**Cataphoresis Apparatus, Northrop-Kunitz,** consisting of cataphoresis cell "A", right-hand electrode vessel "B" with c. p. zinc electrode, and left-hand electrode vessel "C" with c. p. zinc electrode **$35.00**	*Cegln*
2875.	**Cataphoresis Assembly, Mudd,** consisting of No. 2873 Northrop-Kunitz Cataphoresis Apparatus; special Zeiss Microscope with 10X Huyghenian ocular, crossline micrometer, achromatic objective 20X, 8.3 mm focus, 0.40 N. A., blue glass disc, and Siedentopf Changeover Condenser for immediate interchange from bright to dark field illumination; Zeiss Incandescent Micro Lamp for use on 110 volts; baseboard of quartered oak, with supports and clamps. Complete as shown in illustration **$171.00**	*Cegym*

NOTE—In addition, there is required a stopwatch, a mercury commutator or pole changing switch, a source of direct current, a d.c. voltmeter, and an electrometer or potentiometer for the calibration of the potential gradient.

Detailed description of the above apparatus, with prices on the individual parts, bibliography, etc., sent upon request.

Sole Distributors

ARTHUR H. THOMAS COMPANY

RETAIL—WHOLESALE—EXPORT

LABORATORY APPARATUS AND REAGENTS

WEST WASHINGTON SQUARE PHILADELPHIA, U. S. A.

Cable Address, BALANCE, Philadelphia

SCIENCE

VOL. LXX — FRIDAY, AUGUST 23, 1929 — No. 1808

The Rôle of Physics in Modern Industry: DR. L. O. GRONDAHL 175

Obituary:
Captain Charles Frederick Silvester: PROFESSOR CHARLES F. W. MCCLURE. *Recent Deaths* 183

Scientific Events:
Bird Sanctuaries in London; The Investigation of Air Pollution at the Mellon Institute; The Des Moines Meeting of the American Society of Zoologists and the Section of Zoological Sciences of the American Association; The Nineteenth International Congress of Physiology 185

Scientific Notes and News 188

University and Educational Notes 191

Discussion:
A Note on the Association of Diseases: PROFESSOR RAYMOND PEARL. *Parthenogenesis and Polyembryony in Alnus rugosa:* ROBERT H. WOODWORTH. *A Bombarding Dicaelus Beetle:* P. W. FATTIG 191

Quotations:
The Seventieth Birthday Anniversary of Theobald Smith 193

Scientific Books:
Henderson and Davie on Incomes and Living Costs of a University Faculty: DR. JOSEPH JASTROW 194

Scientific Apparatus and Laboratory Methods:
A Safety Razor Blade which Cuts as Well as the Best Microtome Knives: PROFESSOR ALFRED F. HUETTNER. *Another Petrographic Method:* DR. R. C. EMMONS 196

Special Articles:
A Method of Determining the Axial Ratio of a Crystal from X-ray Diffraction Data: The Axial Ratio and Lattice Constants of Zinc Oxide: DR. M. LUTHER FULLER 196

The North Carolina Academy of Science: H. R. TOTTEN 198

Science News x

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL and published every Friday by

THE SCIENCE PRESS

New York City: Grand Central Terminal

Lancaster, Pa. — Garrison, N. Y.

Annual Subscription, $6.00 — Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

THE RÔLE OF PHYSICS IN MODERN INDUSTRY

By Dr. L. O. GRONDAHL

UNION SWITCH AND SIGNAL COMPANY, SWISSVALE, PENNSYLVANIA

IN speaking of the rôle of physics in industry, I shall dwell on its accomplishments in the way of making itself useful to the engineer, to the factory operator and to the public generally. As I shall point out incidentally, the service is not one-sided, and an interesting chapter could be written on the service of industry to physics and to other sciences. It is hoped that this will be remembered if at some times I appear to get enthusiastic and to claim too much for the science which is my hobby. To give a glimpse of the other side of the picture, I shall first proceed to make an acknowledgment of the great debt that physics owes to industry and which was incurred before either industry or the science was organized.

Physics originated in the arts and crafts of prehistoric and early historic times. The students and philosophers of those days played no part in the beginnings of the science since they thought of their activities as being on a different plane from the activities of those who labored with material things and were not inclined to interest themselves in anything of a physical nature except philosophically. They attempted to arrive at an understanding of nature by speculation. This attitude made it impossible for them to learn of the characteristics of things from experience. Soldiers, sailors, shepherds, craftsmen, builders and others who had to do with physical things were the ones who not only developed an acquaintance with physical characteristics, but who also learned to apply principles that were not formulated, but were useful, and that later became the foundation of physics.

These workmen learned how to do many things that have been the bane of the existence of young students ever since physics became a part of the curriculum. They learned to use the lever or the inclined

plane to raise their weights, to use the wedge when they wanted to split a piece of timber and to make use of kinetic energy when swinging the axe or the hammer. They knew how to use fire, and not only that, but they learned how to transform mechanical energy into heat enough to start a fire before any one had ever suggested that heat had a mechanical equivalent. They had found out that by building a craft which could be used to displace water it was possible to float over the lakes and the rivers and the oceans. They knew how to make use of action and reaction in their oars and the rudders of their boats and how to use the composition of forces and the analysis of forces to make their sails effective. They used compasses before there was ever written a chapter in regard to magnetism. They were acquainted with the practical value of capillary action, which they made use of in the wicks of their lamps. Centrifugal force was known and applied in the use of the sling. The bow and arrow is a good illustration of the transformation of potential into kinetic energy. They used heat insulation in their clothes and in their houses. They used mirrors, and lenses in the form of burning glasses, before refraction was understood, and so on. The list could be extended very much farther and I have given all these illustrations only to emphasize the fact that a great deal of physics was known long before there was ever a book written on the subject and long before there was ever a man who could be called a physicist. This illustrates how closely physics is related to many human activities and shows that it had its origin in this very practical fact. The first physics was applied physics, and applied physics has existed ever since human beings began to exercise their ingenuity with mechanical things, although it is only recently that the physicist as such has entered the practical field.

A striking illustration of the fact that physics was originally practical is to be found in that well-known experiment of Archimedes which became the basis of what is known as Archimedes' principle in regard to buoyancy. Archimedes performed that experiment in order to answer a practical question. The story goes that his king had bought what he was told was a gold crown. Being of a suspicious nature, he wanted to determine whether the crown was all gold or whether it had been loaded with lead on the inside. He wanted to determine this without spoiling the crown and gave the problem to Archimedes. After some thought Archimedes decided that by weighing the crown in air and in water and also by weighing pieces of gold and pieces of lead in air and in water he could determine how much was gold and how much was lead in the construction of the crown. Archimedes' principle is, therefore, the outcome of a very clever solution of a practical problem. While Archimedes is known as a philosopher and a physicist, he was also responsible for many inventions. He evidently gave a good bit of thought to the solution of practical problems. He devised a complicated system of pulleys for moving ships up on the beach and is said by some to have been the inventor of the screw as an instrument for raising heavy weights.

It was not until the sixteenth century that science and especially physics began to become organized. This organization began with such work as that of Galileo and Newton and so had its origin partly in astronomy, and since then it has grown on the foundations that had been laid by the artizans, until at the present time we have a rather elaborate set of facts and principles known as the science of physics.

This science consists of the known facts in regard to matter and energy and the generalizations based on these facts. These generalizations enable us to classify many physical phenomena and to describe them in such simple terms that we can work with them, show how they are related to one another and develop new and useful combinations, without having to cut and try quite as much as did the men who discovered and developed the first useful physical devices. Much of the rapid growth of new industries which has taken place in recent years is due to this possibility of making new combinations. Of course, this possibility increases very rapidly with the number of facts and principles that are available. From this some of the service that physics can bestow upon industry is at once apparent.

During the last few decades, there have sprung up a great number of branches of physics which have separated from the parent science and acquired new names. They are practical applications of physics, and most of the branches of engineering have originated in this way. All the physical branches of engineering are really applied physics, so that every civil, mechanical, electrical, illuminating or telephone engineer is a physicist who has specialized in one particular branch of the subject, and in that branch especially in its practical applications. Many of these branches of engineering originated as appendages of departments of physics. You all know that in various institutions in the country, departments of mechanical engineering, of electrical engineering or of illuminating engineering have originated as special courses in physics. Gradually, as the demand for the work increased and the work was expanded, more of the practical subjects were added and they grew away from the physicist. The engineer had to learn to draw and to make designs and to do many other things that the physicist had not learned. In these developments of designs and of practical apparatus,

the engineer encountered many questions that the physicist was unable to answer. The physicist was not only unable to answer them, but was inclined not to spend time on them because they were too specialized. The engineer performed his own experiments and found his own answers and in this way he gradually built up these several branches of physics which appeared more and more different from the parent science. It became necessary then to separate these groups of subjects from the departments of physics and they became the corresponding engineering departments.

The engineering branches gradually grow away from physics especially in that they formulate the principles that they use in their own way and the connection is soon more or less obscured. The principles become narrower because they are used in special practical applications. The equations of physics are rewritten to serve special purposes and to give the values of quantities in which the physicist as such is not so often interested. The broad statements used in the general subject of physics are no longer necessary. In fact, in many cases, the broad statements are not as valuable as the more specific statements which answer more specific questions brought out in the designing, testing or using of practical equipment.

In spite of the transformation which the various special branches of physics underwent at the hands of the engineer it was nevertheless physics that he took with him into industry and that he used as the basis of his practical work. He took the laws of statics and dynamics and the laws of thermodynamics and built the vast specialized fields of civil and mechanical engineering. He took the laws of electrodynamics and built electromagnetic machinery and developed the science and art of electrical engineering and the enormous electrical industry. He took the principles of optics and built illuminating engineering and the corresponding industry. In the beginning, it was possible to carry on in each of these fields with very simple principles, simply stated. As industry grew and more complicated devices were developed, it became necessary to apply more and more of the principles of physics, the engineering branches began to overlap, the electrical engineer began to need the assistance of the mechanical engineer and others and *vice versa*. It became more and more essential for the engineer to be a general physicist. What more natural, then, than to invite the physicist to come with his science. So it happens that not only physics, but also the physicist is back in the industries where he had his origin. Physics and industry are inextricably interwoven with one another and have been mutually stimulating and helpful.

Parenthetically it may be remarked that all sciences seem to have had their origins more or less in a real or an imagined practical need. Astronomy developed from the requirements of navigation and the requirements of astrology. Medicine grew from the obvious need to cure diseases. Mathematics developed from the necessity of using numbers and of making measurements, and so on.

The industrial physicist is usually, but not always, found in a portion of the plant that is known as the research department. There it is his function to transmit to the rest of the plant the benefits that may be derived from the study of his subject.

In 1927, $217,000,000 was spent for research in the United States. Of this, $200,000,000 was spent in industrial research in approximately one thousand laboratories. It may be assumed that more than one half of this money was spent in physical research. This great interest in research as well as the great interest that industry has taken in physics developed during and immediately after the war. It developed as a result of the fact that during the war the whole nation became practically one industry and it became necessary to expend every possible effort to do more, and to do more that was new, than was ever required during the same length of time under peace conditions. This high-pressure industry, which in this country *was* the war, made it necessary to get every help possible, and while the industrialist in the beginning was not convinced that the laboratory man from the university could do him much good, he was convinced that it was necessary for him to do everything that could be done, and since it was *possible* that the scientist could help, he took a chance and gave the scientist his opportunity. The scientists, principally the physicist and the chemist, were equal to the occasion and their ability to produce was so striking that they have had an important place in industry ever since. New things had to be done and it was demonstrated that there were many possibilities of new results in the knowledge and the experience of the university laboratory men.

In addition to having served as the basis of nearly all the branches of engineering, physics is serving industry in a great number of more direct ways, some of which I shall now try to enumerate. Physics is primarily a quantitative science, and it is a quantitative science that deals with physical phenomena and physical characteristics. Physical phenomena and characteristics are the materials used in the industries, and it becomes at once the natural thing to look to physics for the methods of measurement that are used to determine characteristics and to measure physical changes. Physicists have developed methods of measuring almost everything with which they are acquainted. In fact, some say that physicists do not

profess to know what they can not measure. The methods of measurement, which some years ago were known to be useful only in the theoretical laboratory, are gradually being taken to industry and it becomes the physicist's task not only to teach them, but also to show how they can be used to get the data that the engineer uses in his designs and developments. It is evident at once that physics in the person of the industrial physicist becomes a supplement to the engineer. His understanding of methods and principles of measurement makes it natural to depend on the physicist for standardization of processes, materials, methods of measurement and instruments that are used in the measurements. Accordingly, some industries assign to the physics laboratories the writing of materials and process specifications. In fact, any materials and process department is in reality a laboratory of physics and chemistry, although it does not always carry the name.

A good illustration of such service in connection with measurements and shop problems may be seen in the recent history of the paint industry. A few years ago, the hardness of a paint or a varnish surface was determined by scratching it with a fingernail; colors were known by name and were compared with standard colors which changed with time. There was no adequate standard "white" and no satisfactory measure of hiding power. One physicist, Dr. A. H. Pfund, of the Johns Hopkins University, in a few years found solutions for all these problems by the applications of fundamental principles and of the ingenuity which he had developed in a long laboratory experience. His hardness tester consists in a small piece of apparatus in which hardness can be read directly in terms of the diameter of a small circular area seen in a microscope. He has shown how the comparison of colors can be made with high precision and how the question whether a body is or is not white can be determined without using a standard of comparison. In both the latter problems he made use of the fact that the color of the reflected light from an object is accentuated by multiple reflections. The hiding power of a paint was measured by the clever use of a wedge-shaped body of paint pressed between two pieces of glass.

In a similar way many shop and production problems call for the assistance of the industrial physicist. Take, for instance, as a problem the study of the behavior of a paint or a varnish that is used for insulating purposes. It becomes necessary to study its electrical resistance through the film and over the surface, its dielectric strength, its absorption of water and the effect of this absorption on the electrical properties, its resistance to the action of ultra-violet light and to weathering influences generally, its hardness, brittleness, flexibility and other characteristics, all of which require physical measurements and the application of well-established physical principles, and are best carried out in a physics laboratory.

Physics as represented by the industrial physicist should take an important part not only in the standardizing of methods of measurement but also in the choice of characteristics to be measured and in the making of definitions of the units to be used in the measurements. In many cases the characteristics that need to be measured are still not chosen. That has to be done before the method of measurement and the units can be decided upon. A national society of applied physics such as has been proposed by the Akron Society of Applied Physics could certainly be helpful in promoting such standardization.

Constant and intimate contact with the products of scientific work develops in the individual an appreciation of scientific method. It does not necessarily result in acquiring the scientific method of thinking or of investigating. It is one of the functions of physics and of other sciences in industry to lead the way in the use of the most effective method. In practical questions it is often not possible to use it fully. Results have to be got in a hurry since the answer may have commercial value and its postponement is expensive. When time is available, the method of physics is to gather all pertinent data carefully and impartially, to subject them to thorough and unprejudiced examination and analysis, to check the conclusions experimentally and then to give the answer, unless, as often happens, analysis of the first set of data reveals the necessity of repeating the whole process before a conclusion can be reached. While the process usually can not be followed in its entirety, the principle can be kept in the foreground even when its application is imperfect. If the physicist is the right sort, his own attitude and his own methods will sell the idea of the importance of the scientific attitude to those with whom he comes in contact. Thus, he and his science should be a sort of leaven in the industrial organization. Their influence should be to develop a frank, honest and thorough consideration of all problems, an openness to suggestions of whatever kind and from whatever source, a conservatism toward untried devices and ideas and at the same time an optimism towards the possibility of making improvements which should stimulate every one in the organization to his best efforts. It should become a habit to obtain as far as possible all available facts in regard to any problem, to weigh them carefully and to direct the efforts of the organization in accordance with the results.

One usually looks to chemistry to supply new materials, but it is the rôle of physics sometimes to

discover and to demonstrate new uses of materials that are already known or of combinations of such materials. The gas-filled lamp is an illustration of a discovery that has been of enormous commercial and human value. It is the result of the discovery that it is not necessary to mount a lamp filament in a vacuum and that, as a matter of fact, the filament deteriorates less rapidly and can be used at a higher temperature and, therefore, more efficiently if it is surrounded by a gas at a considerable pressure. The new material in this case was the inert gas used as an essential part of an incandescent lamp.

Another illustration of a valuable discovery in materials is the result of the work of the laboratory of the Eastman Kodak Company on films for moving pictures. Physics and chemistry cooperated in this result. The remarkable conclusion was reached that in order that the gelatin made from their hides should be useful for fast moving picture films, it was necessary for cows to eat mustard. The mustard oil is the important ingredient.

It is often said that industry needs more fundamental scientific principles in order to solve its problems. This is doubtless true and every one will agree that the more thoroughly we know nature the better. However, I think it is also true that the science that is already known has only begun to be exploited.

A very interesting case of a new use of known facts is that of the Kodacolor process of making colored moving pictures. It is really a very surprising use of well-known optical properties. The process is based entirely on physics and has for one of its essential elements the formation of a great number of very narrow cylindrical lenses on the surface of the film, 559 to the inch, to be exact. These lenses are a part of the optical system and when the film is exposed they project against the sensitive layer of the film, which is on the other side, three parallel strips of light which have passed respectively through the red, green and blue portions of a color filter placed in front of the lens. Under each of the cylindrical lenses there are then three strips of exposed film, each exposed to the light of one of the primary colors. The exposed film is just like any black and white picture and it looks like magic when the placing of a screen of three colors between the film and the lens of the projector causes the picture to be shown on the screen in its natural colors.

Another illustration may be taken from optics. The use of goggles to protect workmen from ultra-violet and from infra-red radiations in various industrial processes interested Dr. Pfund. Being acquainted with the optical characteristics of gold in thin layers and knowing that it could be applied to glass by sputtering from a cathode in a vacuum-tube, he suggested the use of a glass for goggles which should consist of a thin layer of gold protected by glass on both sides. As you know, thin layers of gold as seen by transmitted light are green. Every one has seen that in gilded glassware. So gold transmits energy in the green portion of the visible spectrum and is opaque to the radiations of longer or shorter wave-lengths. That is, the blue, the red, the infra-red and the ultra-violet are all reflected or absorbed. A thin layer of gold thus affords vision in green and provides protection at the same time. This may be taken as a new and unlooked-for application of an old material, or it may be thought of as a new material to be used as the transparent part of a pair of goggles. In any event, it is the product of an idea born of a thorough knowledge of the characteristics of the substance in question.

These are all illustrations of the combinations of well-known facts and principles in new and useful arrangements. A physicist with a vivid imagination can make these combinations more easily than any one else because he knows the facts and has the principles at his command. If he keeps in touch with new work in his science, he is also prepared to make immediate use of new discoveries.

As an illustration of how new physical facts point to new processes, there is probably nothing more striking than the discovery and the early use of atomic hydrogen in a torch for welding. Atomic hydrogen was discovered and its characteristics were studied in a vacuum-tube. It was found to persist for a certain length of time after forming, and knowledge of its great energy of combination into molecular hydrogen made it evident that it would be possible to get high temperatures without the addition of oxygen and that, therefore, it would be possible to make welds that would be free of oxides and slag. This process is now in practical use. One would not be surprised to learn that many valuable processes lie hidden in known physical principles which have never found application in industry.

On the other hand, there are many illustrations of the effect of practical needs in stimulating new discoveries. In the recent work on television, for instance, there developed a very urgent need of a more sensitive photoelectric cell and one that would be sensitive not only in the ultra-violet end of the spectrum, but that would also have comparable sensitivity in the whole visible spectrum. This requirement led to experiments with various materials in photoelectric cells and recent reports present the very surprising result that a layer of sulphur superposed on a photoelectric material, such as an alkali metal, enormously increases the sensitivity and extends it into all parts of the visible spectrum. The increased

sensitivity makes television possible when applied to actual objects under ordinary conditions of illumination and also makes it possible to get more nearly correct shades in the picture.

This result grew out of the need coupled with the physicist's understanding of what that need implied. He knew that if certain characteristics could be developed in photoelectric cells, the desired result could be accomplished. He knew how to determine experimentally to what degree he had found the required characteristic. It remained to try the "hunches" that followed from the experience that had been accumulated by all the men working in this and in related fields. In all these respects the physicist had the equipment and, in this case, the result soon followed.

Many developments and much progress in industry as well as in science are due to combinations of facts and ideas. The way in which the two work together to produce new, unexpected and valuable results is well illustrated in many of the scientific and industrial events of the last few years. One of the most interesting illustrations to my mind is that of the discovery of radium and of X-rays. In the nineties of the last century, Geissler tubes were very interesting laboratory curiosities and many physicists played with them, both because they were interested in the phenomenon itself and because the tubes were beautiful to look at and interesting to demonstrate to their audiences.

Roentgen was experimenting with such a tube and happened to have a photographic plate lying in the neighborhood of it, the plate being protected as usual with black paper. When the plate was used, it was found to have been light-struck, so that the picture was a failure. Most men would have thought either that the plate was too old or that it was imperfect from the factory or else that, in one way or another, it had become light-struck in the camera. Roentgen, however, was not the type of man to be satisfied with such an explanation. He investigated and put another plate through the same history as the plate that was injured. He found again that the plate was light-struck. After some more experiments he came to the conclusion that some radiation from the tube was able to penetrate the opaque paper and to affect the photographic plate. This was the beginning of X-rays—the combination of a physical fact which most men would have overlooked with an idea born of the imagination of the experimenter that here was a radiation that was able to produce actinic effects and was also able to pass through opaque objects. Nothing like this had been known before, and when one remembers how difficult it is for us to believe the existence of something new it is realized that it was a real act of imagination when Roentgen came to the conclusion that here was a new type of ray.

Becquerel became interested in this phenomenon and noted that the operation of the Geissler tubes produced fluorescence. He knew also that various minerals displayed fluorescence and hit upon the idea that there might be some relation between the two phenomena. He, therefore, took some uranium minerals that were fluorescent and exposed to them a photographic plate which was protected with opaque paper. The plate was affected just as it had been by the radiations from the Geissler tube.

He then began an exploration of these minerals, which consisted first in making analyses and testing the various parts separated out to determine whether the activity was associated with any particular constituent of the mineral. It was found that these minerals were active whether they did or did not show fluorescence, and it was also found that some parts separated out were more active than other parts. Monsieur and Madam Curie undertook the task of separating out the active element and by following the activity through a most complicated analysis, which required not only great technical skill but also the use of a vivid imagination, they succeeded in separating out the most active part of the uranium mineral, and when you remember that the material that was found was not only exceedingly minute in quantity, but was, moreover, a new element, the characteristics of which were learned during the process, you realize that it was a very noteworthy accomplishment.

You may say that this work on radium was chemistry, and it is true that the analysis was of course partly chemical, but it was nevertheless an accomplishment of physics because physical methods were necessary for the detection of the material that was being sought in the analysis. Ordinary chemistry alone could not have found radium. Spectroscopy or the use of the electroscope were essential to the detection of the minute quantities of material that were present.

In this discovery of radium, ideas and facts were combined step by step. The effect of the radiation from the Geissler tube on a photographic plate was combined with the idea that it was due to a new penetrating radiation and the further idea that it might have something to do with fluorescence and that it might be present where fluorescence was present under other conditions. This idea led to experiments which discovered other facts in regard to the characteristics of uranium minerals. Of these facts was born another idea that there is something present in the uranium mineral which is the principal

cause of the activity, and this idea led to the very complicated series of experiments carried out by the Curies and the discovery of radium itself.

There are two other illustrations with which you are all familiar but which are so to the point that I wish to give them. Radio was born when Clerk Maxwell wrote his equations of electromagnetic radiation, or rather we should say that its birth dates back to the experiments of Faraday, which had stimulated Maxwell. He had the insight to see that a displacement current in a dielectric may have the same effect as a conduction current. A few years later, Hertz took the next step by making laboratory experiments in which he demonstrated that Clerk Maxwell's supposition was correct and showed that displacement currents in some respects were the equivalent of conduction currents. From this point radio grew by leaps and bounds through Marconi and others and you are all familiar with that story.

The vacuum tube amplifier is another striking illustration of the same kind of thing. From the Geissler tube, which was simply a glass tube from which most of the air had been pumped out and which had been provided with two electrodes, was born the X-ray tube, and with the X-ray tube it became increasingly important that a good vacuum should be produced. Edison, experimenting with his lamps, discovered the conduction through gas of the partial vacuum from one end of the filament to the other and this served as another starting-point. This led to the construction of valves which were unidirectionally conducting on account of the fact that the source of electrons existed only in the hot electrode. It was found that the amount of current that could be passed through such a valve was limited, and the space charge became apparent. The realization that the effect of a space charge is an electrostatic phenomenon led to the introduction of a grid to neutralize it, and when that is done you have a radio detector or a radio amplifier tube. Step by step the facts generate ideas and the ideas lead to experiments which uncover new facts which stimulate thought to produce new ideas, and so on in a continuous progression of intellectual and physical product.

The injection of new ideas to react with the knowledge of needs and the practical experience of the engineer and the shop man is probably one of the most important *direct* services that can be given to industry by physics. The more completely the physicist can assimilate the facts and principles of his science and the more thoroughly he can lay them bare and show to the engineer their bearing on practical problems, the more valuable is his assistance. Just as the number of possible permutations and combinations of a number of objects increases very rapidly with that number, so the number of practical combinations of physical facts and principles increases with the number and variety of the latter. If you consider the accomplishments that are possible with static electricity or with magnetic bodies or with current electricity, each used without the assistance of either of the others, you find that the number of possible instruments or processes is comparatively small. If you combine the three and use them in combination in your instruments, the number of possible devices and accomplishments is enormously increased. It probably increases as some higher power of the number of fundamental principles that are involved. It is the function of physics not only to teach facts and principles already known and to show their applications but also to add to that knowledge new facts and principles at an increasing rate. Therein lies the practical importance of pure science laboratories.

One of the great values of a thorough acquaintance with fundamental facts and principles is of a negative nature. It prevents persons who have original minds and imaginations from spending time on hopeless projects. Such proposals, for instance, as tide motors of certain types can usually be shown by a little calculation to be impractical. Recently there has been a great deal of enthusiasm about the power of the light from neon lamps to penetrate fog. In some minds there seems to be no appreciation of the fact that a given amount of energy in a given portion of the red part of the spectrum has the same ability to pierce fog whether it comes from a neon lamp or from some other source of light. Experiment shows too that the difference in transmission of light of different colors through fog is like the report of Mark Twain's death. It has been grossly exaggerated.

Another popular fancy of the present day is that subatomic energy will some day be used as a source of power. The probability is very remote, since the breaking up of all but the heaviest atoms must be accompanied by absorption and not by the emission of energy. Although this principle has been announced on what seems to be a sound scientific basis we shall probably hear the suggestion for a long time to come, just as we still have perpetual-motion cranks. It is one of the duties of science to prevent the waste of energy on such projects.

It is very difficult to distinguish between what is fundamental and what is of purely practical value, as is seen from some of the illustrations that I have already given. Consider, for instance, the early work in radium and the early work in vacuum tubes and the most recent practical developments that have resulted. Edison's work is usually eminently practical. Still he sometimes does things that are of fundamental

importance. His discovery, for instance, of the Edison effect has been the basis of the vast development of amplifier tubes and may be classed as of fundamental importance. Rutherford, on the other hand, is a man whose work has been devoted entirely to the study of scientific facts and principles, but nevertheless, some of his work on vacuum tubes, discharges in gases and the electrical constitution of matter has had enormous practical importance. Take as another extreme case Einstein's equation derived from the principle of relativity $mc^2 = E$ representing the relation between mass and energy. This may save industry untold effort and expense by discouraging attempts to make subatomic phenomena into a practical source of power. Taken together with knowledge of atomic weights, it leads to the conclusion mentioned above that atomic energy is generally not available.

In our every-day consideration of the accomplishments of science, we are often tempted to overlook the fundamental work that is at the basis of a new device and to give the man who contributed the final practical application the full credit. This has been the case in radio. The work of Maxwell and Hertz does not usually receive the notice that is given to the work of Marconi, and yet the former was at least as important as the latter.

It would undoubtedly be true that if some one to-day should produce an internal combustion engine that is very much more efficient and very much smoother in its operation than our present gasoline engines he would be hailed as having done something entirely new, while, as a matter of fact, he might be applying old and well-known principles in a new way. Certainly, the discoverer of the fundamental principle that is involved did as much toward the final result as did the man who made the practical application.

Physics is the source of practically all the general scientific principles on which the industries are built, and these principles constitute its greatest contribution toward material accomplishments. The laws of dynamics, known as Newton's laws, and their corollaries are used in every mechanical design, and without them we should probably have had neither modern physics nor modern industry. The laws of thermodynamics are of universal application and directly useful in the study of all kinds of energy transformations, especially in heat engines. The equations of Maxwell at the basis of the development of radio, and the laws of electrodynamics have led to many results that need not be recounted, and as a simpler and still a very important illustration may be mentioned Ohm's law. These constitute the foundation on which physics and engineering, and therefore also modern industry, are built.

There is a still more important service that physics can give to industry and to society in general. This is connected with the philosophical principles on which all the developments of which I have spoken are and must be based. Consider, for instance, the principle of order which we believe applies at least to all macroscopic phenomena of nature. Primitive man did not understand the things that went on around him in the way that we do, and in his efforts to explain to his own satisfaction the things with which he was confronted he peopled nature with a variety of conscious beings, some good and some bad, some friendly and some inimical to his interests. The phenomena of weather, of sickness and of health, of prosperity and of poverty, were all thought to be willed and caused by gods or evil spirits. Primitive man thought himself entirely helpless in all these matters and was governed in many of his actions and many of his thoughts by fear of these supernatural beings and supernatural occurrences.

Science has taught and we believe that all the phenomena of nature including even sickness and health take place according to definite laws that are either known or capable of being known by man. When the laws are known, it becomes possible for man to adjust himself to his surroundings in such a way that the elements that were formerly considered dangerous and evil become his servants. His fear of something capricious and something that he was unable to understand and in the nature of things never could understand has disappeared, and in its place is his faith in the orderliness of nature and in his own ability to understand and to regulate the phenomena of nature to his own advantage.

Physics has done a great deal to bring about this state of mind, and it is of immediate and direct practical advantage in industry. The industrialist, whether he is the financier, the engineer or the shop man, has faith that nature is orderly and that he can control the processes in which he is interested. He is certain that if a process which was satisfactory yesterday goes wrong to-day, it is because conditions have changed. He has no fear that some evil-minded person's curse or the influence of an evil spirit has caused the trouble, so, calmly and without fear, he goes about determining by observation and experimentation what it is that has gone wrong. We usually call this process "shooting trouble," and just imagine, if you can, the state of mind of a shop man who believes the cause of shop trouble is to be sought in the supernatural influence of his enemies or of evil spirits. When things go wrong, he has to close down until

some one who was doing the damage recovers from his indigestion or otherwise acquires a better humor.

Not such a great length of time has passed since we labored under these handicaps. There are parts of the world to-day where evil spirits and witches are real in men's minds and where they accomplish such unfortunate results as the drying up of a cow when she should be giving milk, and other rural calamities.

Our manifold contacts with machinery, mechanical and electrical, has taught every one that at least in such matters a result always has an understandable relation to other circumstances and that the only requisite for satisfactory control of machine and process is sufficient knowledge. So the industrialist has his course of action plainly marked out and he seeks knowledge and more knowledge. The fact that this understanding is a recent acquisition and still not thoroughly a part of us is perhaps illustrated by the fact that when it comes to a matter of our individual physical beings where the machine is not so well understood we are not entirely convinced. At least we are willing to do things to ourselves in the way of eating, drinking or exposure that we know are harmful. It is probably too much to say that we know, since somehow we have a feeling that we shall escape the consequences of our indiscretions. I think it is John Dewey who says that "knowledge is knowledge only when it is translated into habits of action." We should probably say that we know more about our mechanical and electrical machinery than we know about ourselves. One of the functions of physics in industry is to strengthen our conviction of the orderliness of nature.

It is undoubtedly a fact that the teaching of such fundamental principles is the most important contribution of science even when we remember all the physical conveniences and comforts that have resulted. The value of understanding is unbounded. We are just beginning to realize the possibilities in accomplishment that are inherent in an understanding of the physical universe. The aim of physics as a science is to learn to understand fully the nature and the interrelation of physical phenomena, and this at once singles it out as the natural helpmeet of industry.

The characteristics of modern civilization and our mode of living are largely determined by the products of applied science. Land, water and air transportation; telegraph, telephone and radio; the internal combustion engine that made automobiles and aeroplanes possible; the electrical industry, from heavy traction and electrically driven ocean liners to the smallest incandescent lamp, are all so much a part of our lives that it is difficult to imagine what it would be like without them. They are all based largely on physics as are also the machines and processes by which they are produced. Industry is busy in the production and maintenance of these and similar devices. It follows that for the future development of industry, physics must take a great if not the principal part in showing the way. By revealing facts of nature, propounding principles and teaching method, physics must show what can be done and how, and the engineer, who is also a physicist, will work out the details. That, in a word, is the rôle that physics must play in the industry of the present and of the future.

OBITUARY

CAPTAIN CHARLES FREDERICK SILVESTER

THE older anatomists in this country will recall their associate, the late Charles Frederick Silvester, preparator in anatomy and curator of the Biological Museum in Princeton University, whose skill was often evidenced at meetings of the American Association of Anatomists by the anatomical preparations he exhibited.

A descendant, through his mother, of General Putnam, of the Colonial Army, he was born near Princeton, New Jersey, on December 21, 1876, and attended the rural schools in the neighborhood of Princeton. The lure of natural history, which had interested him from boyhood, brought him to my laboratory, where in 1895 he applied for the position of general laboratory assistant. Soon he gave evidence of having a great natural aptitude in the preparation of anatomical material. Within a short time after he entered the laboratory he mounted the disarticulated skull of a young dog in such a manner that it was clear he should train himself to be a professional preparator. He had unusual mechanical ability, and was most ingenious in inventing methods of dissecting and mounting his material; the fact that he was ambidextrous greatly added to his facility. During a period of twenty-two years he developed under my direction the extensive collection of comparative anatomical preparations that constitutes a large part of the present Princeton University Morphological Museum.

Throughout his life Silvester sought opportunities to increase his efficiency in whatever work he was engaged. He attended my courses in comparative anatomy and the development of vertebrates and thus

prepared himself to be my assistant in the undergraduate work in the laboratory. He made several trips abroad to study the collections in European museums, and on one of these trips he exhibited some of his anatomical preparations in London at the international meeting of the anatomists. On this occasion he was elected vice-president of the American Section of the International Association of Medical Museums. In 1899 he accompanied me on the Peary Relief Expedition to Greenland, where he obtained and prepared a large amount of material for the Princeton anatomical collection.

Later Silvester became much interested in the taxonomy of fishes, and in 1915 he made an expedition to Porto Rico with Dr. Henry W. Fowler, where he collected more than a hundred species. Of these, 20 per cent. were new to the fauna of Porto Rico and 8 per cent. were new to science. The results of this expedition were published by Silvester in Year Book No. 14 of the Carnegie Institution of Washington for 1915.

Silvester's publications dealt chiefly with the anatomy of vertebrates and the methods of preparing and mounting specimens for exhibition and study. The most important of these are: (1) "The Blood-vascular System of the Tile-Fish (*Lopholatilus chamaeleonticeps*)." This paper includes a complete description of all blood vessels found in this teleost and for this reason is valuable for reference and comparison.[1] (2) "A Comparative Study of the Lymphaticovenous Communications in Adult Mammals," published jointly with me in 1909.[2] (3) "On the Presence of Permanent Communications between the Lymphatic and Venous Systems at the Level of the Renal Veins in Adult South American Monkeys."[3] In this paper Silvester made the important observation that in New World monkeys the lymphatic system invariably communicates with the veins in both the lumbar and the cervical regions, while in Old World monkeys only the cervical communication is found. (4) "Notes on Mounting the War Collection at the Army Medical Museum and Typewriting Labels on Museum Jars."[4] His method of labeling museum jars is most unique, and is greatly superior to that commonly employed.

Captain Silvester was from boyhood greatly interested in the National Guard, and in 1901 he joined the Second New Jersey National Guard as a private. After first serving as a non-commissioned officer, he was commissioned second lieutenant in 1906, and became captain of the company in 1909. Also in 1909 he was made a state inspector of small arms practice. He was an expert rifle shot and at one time was the champion of New Jersey. In order to pursue his scientific investigations he gave up the opportunity of going to Stockholm as a member of the United States Olympic team.

In 1916 he was inducted into the federal service and, after serving on recruiting duty at different points in New Jersey, was sent for training to Camp McClellan, at Anniston, Alabama, where his company became incorporated in the 114th U. S. Infantry. It was organized as a machine-gun company, and with Captain Silvester in command was sent with the Blue and Gray Division to France in June, 1918, where it saw service in the Belfort sector and in the Meuse Argonne offensive. It was at Anniston that he met Miss Mary Henry, of Gadsden, Alabama, whom he married on April 13, 1918.

After the armistice Captain Silvester remained in France until April, 1919. In August, 1918, he was made munitions officer of the 57th Infantry Brigade, which position he held until December, when he became acting adjutant. Later he was assigned to the Medical Unit, and collected much material on the French battlefields for the Army Medical Museum in Washington, D. C. Upon his return to the United States he was assigned to prepare this material for exhibition and preservation at the Army Medical Museum. Here he remained until November, 1920, when, after passing examinations, he was commissioned a captain in the regular army.

As a regular army officer, he was stationed during 1921 at Petersburgh, Virginia, Camp Jackson, South Carolina, and the Motor Transport School at Holabird, Baltimore; in 1922, at Camp Lewis, Washington; during 1923, at Fort Douglas, Utah, Camp Perry, Ohio, and Fort Niagara, New York. In 1924 he attended and was graduated from the Officers' School at Fort Benning, Georgia, and during the summer was with the R. O. T. C. at Plattsburg, New York; 1925 he spent at Fort Missoula, Montana, and in 1926 he went to the Philippine Islands. He had just returned from the Philippines to the United States, where he had been assigned to the Officers' School at Fort Benning, Georgia, when he was stricken with acute appendicitis and died in the Princeton Hospital, in Princeton, New Jersey, on May 15, 1929.

During the last eleven years of his life, while he was identified with the army, Captain Silvester had but one opportunity to make use of the great skill he had acquired in preparing museum exhibits, but his name will always be closely associated with

[1] Bull. Bureau Fisheries, Vol. XXIV, 1904.
[2] *Anat. Rec.*, Vol. III.
[3] *Amer. Jour. Anat.*, Vol. 12, 1912.
[4] Internat. Ass. Med. Mus. and Jour. Tech. Methods, Bull. No. VIII, 1922.

the part he took in developing the comparative anatomical collection of Princeton University.

CHARLES F. W. MCCLURE
PRINCETON UNIVERSITY

RECENT DEATHS

PROFESSOR FRANK AUSTIN GOOCH, professor emeritus of chemistry at Yale University, died on August 12 in his seventy-eighth year.

DR. GEORGE P. MERRILL, head curator of geology died suddenly on August 16. Dr. Merrill was seventy-five years old.

DR. ANDREW A. KERR, head of the department of anthropology in the University of Utah, died on August 15 at the age of forty-nine years.

ALFRED HUTCHINSON COWLES, metallurgist and inventor, president of the Electric Smelting and Aluminum Company at Sewaren, N. J., died on August 13 at the age of seventy years.

SIR EDWIN RAY LANKESTER, F.R.S., formerly director of the South Kensington Museum and for sixteen years profesor of zoology and comparative anatomy in the University of London, died on August 15 at the age of eighty-two years.

PROFESSOR WALTER GEOFFREY DUFFIELD, of the Commonwealth Solar Observatory at Mount Stromo, of which he had been director since its foundation, died on August 3.

THE deaths are also announced of Dr. John Nicol Farquhar, professor of comparative religion in the University of Manchester; of Sir William J. Thompson, past-president of the Royal College of Physicians of Ireland, and for many years registrar-general for Ireland; of Dr. Hermann Wagener, professor of geology at the University of Göttingen; of Dr. Richard Lorenz, professor of chemistry at Frankfort a.M., and of Dr. Charles Moureu, professor of chemistry in the Collège de France.

SCIENTIFIC EVENTS

BIRD SANCTUARIES IN LONDON

THE report of the Committee on Sanctuaries in Royal Parks contains not only reports of its observers on the different parks, but a review of the progress of bird-life in the sanctuaries since they were established seven years ago.

Referring to Hyde Park and Kensington Gardens, the report, as abstracted in the London *Times*, says that, owing to their situation in the heart of an enormous urban area and to the extent to which they are frequented by the public, these parks can not be expected to compare with the outer parks in the variety and number of their wild birds. In the matter of bird-life the inner parks generally have suffered most from the rapid expansion of London in latter years, and will do so increasingly so long as that process continues. It is feared that in their case, as London goes on spreading, the number of species to be seen will decrease, and that all that can be done is to retard the diminution, a task in which the sanctuaries are undoubtedly rendering very valuable service.

Since the establishment of the sanctuaries representatives of over eighty species of wild birds have been observed in Hyde Park or Kensington Gardens—fifty-one species which are to be seen in this country throughout the year, twenty-four species which are summer visitors and nine which are winter visitors. The number of species nesting within the area has averaged about seventeen a year. The list for 1928 is as follows: Blackbird, chaffinch, ringdove (wood pigeon), tufted duck, spotted flycatcher, greenfinch, mallard, moorhen, redbreast, hedge sparrow, house sparrow, starling, missel thrush, song thrush, blue tit and great tit.

Years ago Kensington Gardens contained the main rookery of London, but rooks, which require a wide foraging area of soil, have for years past found the task of supporting themselves in inner London beyond their power, and they are not expected to breed there again. Jackdaws, too, a small contingent of which still haunts Kensington Gardens, are giving up the struggle against the growth of London, and, although a few nested in the gardens up to 1926, it is feared that they no longer do so.

On the other hand, the wood pigeon, which formerly was rarely seen in this area, has found conditions to its liking and has clearly come to stay, while the mallard and moorhen are also increasing. The great crested grebe, which was at one time unknown in these parks, now visits the Serpentine or Round Pond every year. The chaffinch, a bird formerly seldom found in these parks except in bitter weather, is now to be seen there throughout the year, and nests regularly in fair numbers. The goldfinch visits Kensington Gardens more often of late, probably attracted by the teasels which have been planted in the sanctuary. The greenfinch also comes to the central parks more frequently than it did a few years ago, and has recently nested there. The meadow pipit is often to be seen, and at any time of the year.

THE INVESTIGATION OF AIR POLLUTION AT THE MELLON INSTITUTE

DURING 1911–1914 Mellon Institute sponsored the first broad scientific study of smoke abatement. This preliminary investigation had as its objects the determination of the extent of air pollution by smoke in the city of Pittsburgh and the initiation of preventive measures to curb the smoke nuisance. After sufficient data had been obtained on sootfall, legislation was directed toward the minimization of dense smoke; obnoxious gases and solids not imparting color to the smoke stream were not considered then. This legislation served as a basis for smoke abatement laws in other cities in the United States and even in Europe, particularly in England.

Subsequently, in 1923–24, a supplemental survey was made by the institute to determine the effect of the Pittsburgh ordinance on the state of atmospheric pollution. The data showed an approximate decrease of 70 per cent. in smoke, but an increase of 40 per cent. in total solids, as compared with the results of the first investigation.

The results of the two studies have been incorporated in ten bulletins and a number of papers published by the institute. The following improvements in conditions brought about by the smoke abatement regulations may be pointed out: material reduction in dense smoke; improvement in combustion methods; improvement in boiler and furnace design, and increase in possible sunshine with a corresponding decrease in the number of "dark days."

This work has recently been reestablished as one phase of the institute's basic, non-commercial research. The investigation is in charge of W. A. Hamor, assistant director of the Mellon Institute, and H. B. Meller, senior industrial fellow. The latter was head of the survey in 1923–24. At the present time they are being aided in the experimental work by four assistants, but the comprehensive plans for future work will necessitate a larger personnel.

In a broad way, the goal of this work is not only to arouse public interest in the evils of air pollution, but also to develop, to propose and to secure the initiation of effective and economically feasible measures for relief. It will be necessary to consider, in addition to "dark smoke," the solids and obnoxious gases that do not give dark color to the gas stream.

The more specific topics which a study of this scope will entail include: methods of sampling and analyzing air; characteristics of effluent gases from different types of buildings, such as industrial plants, commercial plants, private dwellings, locomotives, steamboats and automobiles; determination of the amounts and characters of the emissions from boilers and furnaces under different conditions of loading, fueling and firing; effects of different kinds and amounts of solids in the absorption of light rays of certain wave-lengths; effect of solids in the atmosphere on the formation and character of fogs; effect of different velocities of air currents in dispersing fogs containing different percentages and sizes of solids; effect of barometric pressure changes on the stability of fogs.

The extension of the investigation into the field of public health is of such general interest that it deserves special mention. The comparatively unknown effects on health of smoke, visible and invisible, present a field for inquiry whose importance can hardly be overestimated. Then, too, the hygienic aspects of natural ultra-violet radiation will be searchingly studied.

LAWRENCE W. BASS

THE DES MOINES MEETING OF THE AMERICAN SOCIETY OF ZOOLOGISTS AND THE SECTION OF ZOOLOGICAL SCIENCES OF THE AMERICAN ASSOCIATION

SECTION F and the American Society of Zoologists will hold sessions for the reading of papers on Monday, Tuesday and Wednesday, December 30, 31 and January 1. Following the policy of recent years the program will be arranged with formal reading of papers in morning sessions and informal demonstration presentation in afternoon sessions. Those who expect to contribute should indicate which type of presentation they prefer. In accord with the usual practice all contributed papers will appear in the program of the American Society of Zoologists, Section F holding no separate sessions for the reading of papers. The address of the retiring vice-president of the section, Dr. M. F. Guyer, entitled "The Germinal Background of Somatic Acquirements," will be given immediately following the zoologists dinner on Monday or Tuesday evening. The business session of the section will come on Tuesday afternoon, immediately preceding the business session of the Society of Zoologists. Hotel headquarters for both groups will be the Hotel Savery, 4th and Locust Sts.; all rooms are with bath and range upward from $3 for single rooms and $4 for double rooms. Reservations for hotel accommodations should be made early by members and directly with the hotel, not through secretaries or local committee. Other hotels are available, a list of which will be given in an early issue of SCIENCE. Arrangements have been made for the usual railroad rates of a fare and a half and will be specially announced in the preliminary announcement of the permanent secretary. In securing transportation a first-class one-way ticket should be purchased and for each ticket a certificate

for the Des Moines convention of the American Association for the Advancement of Science and Associated Societies should be obtained. This certificate should be presented at the registration offices immediately upon arrival and called for at the same place the next day; a half-fare returning ticket may be procured after obtaining a validated certificate. Return Pullman reservations on trains should be procured or reserved at the station immediately upon arrival.

Members of Section F who desire to present papers should send the exact title and an abstract of not more than 250 words to reach the secretary not later than November 15; titles received later than this can not be placed on the program and titles without abstracts will not be considered or accepted. The group (cytology, embryology, parasitology, protozoology, comparative anatomy, general physiology, etc.) in which the paper is to be read and whether charts or lantern slides will be used should be indicated. The rules of the American Society of Zoologists are followed in arranging the program and conducting the sessions; members are limited to a total of 15 minutes whether for one or several papers, and the time of students or others introduced by a member are included within the 15-minute limit. The titles and abstracts should be sent as early as possible, either to the secretary of the American Society of Zoologists, Dr. D. E. Minnich, Zoology Building, University of Minnesota, Minneapolis, Minnesota, or to the secretary of the section. The secretary of the section will be at the address indicated below from September 15 to January 20.

GEO. T. HARGITT,
Secretary of Section F

DEPARTMENT OF ZOOLOGY,
DUKE UNIVERSITY,
DURHAM, NORTH CAROLINA

THE NINETEENTH INTERNATIONAL CONGRESS OF PHYSIOLOGY

THE Nineteenth International Congress of Physiology opened at Harvard University on August 19, under the presidency of Professor William H. Howell, of the Johns Hopkins University, with more than 1,000 physiologists from all parts of the world in attendance. Thirty-five countries were represented.

The congress met in the United States at the invitation of the American Physiological Society, and the Federation of American Societies for Experimental Biology has shared with the American Physiological Society the honor of acting as hosts. Dr. Walter B. Cannon, of the Harvard Medical School, was chairman of the bureau in charge of arrangements.

Surgeon-General Hugh S. Cumming, of the U. S. Public Health Service, gave the opening address of welcome on behalf of the United States government. He was followed by Lieutenant-Governor William S. Youngman, who welcomed the members on behalf of the Commonwealth of Massachusetts. President A. Lawrence Lowell, of Harvard University, and Dr. Howell, president of the congress, gave addresses of greeting. Professor August Krogh, of the University of Copenhagen, director of the Zoophysical Laboratory at the University of Copenhagen, who was awarded a Nobel Prize for his work on the physiology of the capillaries, then gave an address on "The Progress of Physiology." Following the opening meeting there was a reception to the members in the Harvard College Yard.

The scientific sessions, beginning on August 20 and closing on August 23, were held at the Harvard Medical School, the High School of Commerce and the Peter Bent Brigham Hospital. An address entitled "Reminiscences of the Early Days of the Physiological Congresses" is delivered on Friday afternoon by Dr. Leon Fredericq, professor emeritus at the University of Liège, a past president of the congress.

The international committee includes Dr. William H. Howell, president of the congress; Dr. Filippo Bottazzi, of the University of Naples; Professor Otto Frank, of the University of Munich; M. Eugene Gley, professor of physiology at the Collège de France, Paris; Dr. Archibald V. Hill, of the University of London, and Dr. Johan E. Johansson, of the University of Stockholm, a past president of the congress.

Elaborate arrangements were made to receive the incoming members and their families. The dormitories of Harvard University were open to receive guests. At the Harvard Medical School a post office, a telegraph and cable office and a telephone office, a bank and an office of Thomas Cook and Son were installed. Throughout the congress buses carried members between the dormitories in Cambridge and the Harvard Medical School. In addition to the scientific sessions a number of entertainments were planned. On Thursday evening a dinner was tendered by the Federation of American Societies for Experimental Biology.

After the close of the congress on Friday afternoon a number of trips have been arranged for the foreign members. A party will go to Woods Hole to inspect the Marine Biological Laboratory. Arrangements have been made for a week in New York City, after which some members are visiting Canada and some will attend the Ninth International Congress of Psychology at New Haven.

SCIENTIFIC NOTES AND NEWS

PROFESSOR WILLIAM MCPHERSON, dean of the department of chemistry in Ohio State University, will be president of the American Chemical Society for 1930 as the result of a special election. Dean McPherson, who will succeed Dr. Irving Langmuir, of Schenectady, N. Y., assistant director of research of the General Electric Company, was named by ballot of the council. Officially he becomes president-elect, Professor Samuel W. Parr, of the University of Illinois, who had been chosen for this post at the last regular election, being unable to serve.

AT the close of the forty-eighth annual meeting of the Society of Chemical Industry at the University of Manchester the doctorate of science was conferred on Dr. Arthur D. Little, of Cambridge, Mass., and on Francis Howard Carr, a former president, of the University of Manchester. The presentation of the society's gold medal to Sir Richard Threlfall was a feature of the closing proceedings of the annual meeting in recognition of his work on the use of helium in airships and with instruments for detecting the presence of explosives in gases.

THE Franklin Institute, of Philadelphia, has awarded its Elliott Cresson gold medal to Sir James C. Irvine in consideration of his researches in carbohydrate chemistry.

THE Baly Medal of the Royal College of Physicians, of London, for distinction in the science of physiology has been awarded to Dr. Edgar Douglas Adrian, F.R.S., and the Bisset-Hawkins medal for advancing sanitary science and public health to Professor Edward Mellanby, F.R.S. The Murchison scholarship has been awarded to Ian G. W. Hill, M.B., of Edinburgh University. In 1930 Professor J. B. Leathes will deliver the Harveian oration, Dr. W. E. Hume, the Bradshaw lecture; Dr. Andrew Balfour will be Fitz-Patrick lecturer; Dr. Carey F. Coombs, Lumleian lecturer; Dr. Donald Hunter, Goulstonian lecturer; Dr. J. J. R. Macleod, Oliver-Sharpey lecturer, and Dr. L. S. T. Burrell, Mitchell lecturer. Dr. M. J. Stewart is the Croonian lecturer for 1931.

M. JEAN GERARD, secretary of the International Union of Pure and Applied Chemistry, has been elected a member of the Legion of Honor by the French government. A dinner celebrating this occasion was held recently by his many professional associates.

PROFESSOR W. H. HOFFMANN, of the Finlay Institute in Havana, has been elected a member of the Société Linnéenne de Lyon.

PROFESSOR RAYMOND A. DART, professor of anatomy in the University of the Witwatersrand, Johannesburg, has been elected a corresponding member of the Italian Society of Anthropology, Ethnology and Comparative Psychology.

PROFESSOR F. A. E. CREW, of the animal breeding research department of the University of Edinburgh, has been elected a foreign member of the Czechoslovak Agricultural Academy.

THE eighth William Thompson Sedgwick memorial lecture was given in the auditorium of the Marine Biological Laboratory, Woods Hole, Massachusetts, on August 16, by Torsten Thunberg, M.D., professor of physiology in the Royal University of Lund, Sweden. The subject of the lecture was "The Hydrogen-Activating Enzymes of the Cells."

VISITING lecturers for the symposium on physiology and biochemistry which was held at the University of Minnesota from July 15 to August 15 included Professor M. von Frey, professor of physiology and director of the physiological institute, Würzburg; Professor Otto Meyerhoff, of the Kaiser Wilhelm Institute, Berlin; Professor T. Thunberg, of the University of Lund, Sweden; Professor G. v. Anrep, lecturer in physiology at the University of Cambridge; Professor E. Laqueur, director of the pharmacotherapeutic laboratory in the University of Amsterdam, and Professor E. Waldschmidt-Leitz, of the German Technical High School at Prague. Dr. H. Strughold, of the University of Würzburg, and many members of the Minnesota and Mayo Foundation faculties also lectured.

DR. WOLFGANG W. PANZER, of the Geographical Institute of the University of Berlin, has been appointed visiting lecturer in geography at the University of California for the year 1929–1930; Dr. Werner Heisenberg, director of the institute for theoretical physics at the University of Leipzig, and P. A. M. Dirac, of the University of Oxford, will also lecture at the university during the coming academic year.

OFFICERS of the Comité International d'Histoire des Sciences which recently met in Paris have been elected as follows: Dr. Charles Singer, of England, *president;* Professor Florian Cajori, of the University of California, Abel Reay, of Paris, and Karl Sudhoff, of Leipzig, *vice-presidents,* and Aldo Mieli, of Paris, *secretary.* The first International Congress on the History of Science was held at Oslo, Norway, last year, and a third congress is planned for London in 1931.

THE following have been elected officers for the session 1929–30 of the British Institute of Radiology

incorporated with the Röntgen Society: *President,* Mr. C. Thurstan Holland; *past presidents,* Sir Humphry Rolleston and Dr. G. W. C. Kaye; *vice-presidents,* Sir William Bragg, L. A. Rowden and Major C. E. S. Phillips; *honorary treasurer,* D. B. McGrigor; *honorary secretaries,* Dr. Stanley Melville and Dr. G. Shearer; *honorary editors,* Dr. G. W. C. Kaye and Mr. R. J. Reynolds.

DR. J. E. MILLS has resigned as chief chemist of the Chemical Warfare Service and as chief of the research division of the Edgewood Arsenal, on June 30, to accept the position of chairman of the division of chemistry and chemical technology, of the National Research Council. M. E. Barker has been assigned to duty as chief of the research division of the arsenal.

C. F. STAHL, who for the past five years has been chief entomologist on the staff of the Cuba Sugar Club Experiment Station of the Tropical Plant Research Foundation at Baraguá, Cuba, has recently returned to the U. S. Bureau of Entomology to accept a position as entomologist in the division of truck crop insects. He will be detailed to the bureau's field station at Chadbourn, North Carolina, where he will study insect pests of strawberries.

FRANK M. GENTRY, formerly assistant to the mechanical engineer of the New York Edison Company and for many years principal assistant engineer with Geo. A. Orrok, consulting engineer, has resigned from the New York Edison Company to join the staff of Lehman Brothers, bankers.

DR. JAMES LINCOLN MCCARTNEY, late fellow in psychiatry of the National Committee for Mental Hygiene at the Institute for Child Guidance, New York City, has been appointed chief of the division of mental hygiene of the Connecticut State Department of Health.

WE are informed that a note sent from Wesleyan University concerning the acquirement of fossils of the Miocene period was somewhat incorrect. The fossils were purchased from the Colorado Museum of Natural History through Mr. J. D. Figgins, who has been director of the museum since 1910.

DR. GEORGE B. WISLOCKI, associate professor of anatomy, and Dr. Adolph H. Schultz, assistant professor of physical anthropology, at the Johns Hopkins University, have returned after a two months' expedition into jungles of Central America for the purpose of obtaining monkeys for scientific investigation and study.

PROFESSOR J. S. KINGSLEY and his daughter sailed from San Francisco on August 16 for a trip around the world. They plan to reach New York in July, 1930. Their mailing address is in care of Credito Italiano, Florence, Italy.

PROFESSOR H. J. QUAYLE, professor of entomology at the Citrus Experiment Station and Graduate School of Tropical Agriculture, at Riverside, has been granted leave of absence from the University of California until June 30 of next year to investigate the life history and habits of the Mediterranean fruit fly in the countries where it appears to have originated. Professor Quayle will visit the countries around the Mediterranean, cruising in the private yacht of Allison Armour, a collaborator of the U. S. Department of Agriculture. Mr. Armour has his yacht fitted up with greenhouses and other equipment which will be available for the work. The yacht was formerly used for the plant introduction work under David Fairchild.

WM. T. COX, recently superintendent of the Upper Mississippi Wild Life and Forest Reserve of the U. S. Biological Survey, and Professor Donald M. Matthews, professor of forest management in the School of Forestry of the University of Michigan, sailed on August 10 for Brazil, where as employees of the Brazilian government they will undertake the organization of its Forest Service. Mr. Cox, who has been identified with the U. S. Forest Service and with the Forest Service of the State of Minnesota, expects to remain in Brazil as chief forester for a period of three years or more. Professor Matthews, after devoting six months to the Brazilian service as associate forester, will return to the University of Michigan.

DR. AND MRS. EDWIN E. HONEY, both recently members of the teaching staff of Albion College, Michigan, sailed on August 10 for Brazil, where Dr. Honey will take up his work as head of the department of plant pathology of the State Agricultural College of São Paulo, in the Escola Agricola "Luis de Queiroz" at Paracicaba. Dr. Honey has been engaged during the past ten years in research and educational work in botany and plant pathology at Cornell University, the University of Illinois, the University of Washington and Albion College.

DR. HANS MOLISCH, professor of botany in the University of Vienna, has returned from a year's visit to India, where he carried out researches in plant physiology.

THE celebration of the centenary of Paul Schutzenberger will take place in Paris on November 7. The President of France will preside at the ceremony at the Sorbonne, which the president of the council and several ministers will also attend.

A MONUMENT to the late Dr. Cabanès, medical historian, will be dedicated in the cemetery at Gourdon (Lot), France, on September 1.

A WINDOW in the Eccles Parish Church of Manchester, England, was dedicated on July 25, in memory of the late Dr. William W. Mayo, father of Drs. Charles and William J. Mayo, who were both present at the ceremony.

THE Ramsay Memorial Fellowship Trustees have made the following awards of new fellowships for the session 1929–1930: A British fellowship, tenable for two years, to Mr. O. H. Wansborough-Jones, B.A., for work at the University of Cambridge. A British fellowship, tenable for one year only, to Mr. R. J. Phelps, B.Sc., for work at the University of Oxford. A Canadian fellowship to Mr. L. M. Pidgeon, B.A., M.Sc., Ph.D., for work at the University of Oxford. A Japanese fellowship to Professor Y. Nagai, for work at University College, London. A Spanish fellowship to Don Andres Leon y Maroto, for work at University College, London. A Swedish fellowship to Mr. E. K. Troell, Phil.lic., for work at the Rothamsted Experimental Station, Harpenden. The trustees have renewed the following fellowships for the session 1929–30: Mr. H. Bienfait, Ph.D. (Netherland Fellowship), for work at the Imperial College of Science and Technology, London. Mr. Peter Maitland, B.Sc., Ph.D. (Glasgow Fellowship), for work at the University of Cambridge. Sir Robert Waley Cohen has been appointed vice-chairman of the trust, *vice* the late Sir John Brunner, and Mr. Henry Mond, M.P., has been appointed a trustee.

THE second Italian Congress of Eugenics will be held in Rome from September 30 to October 2, with Premier Mussolini as president of honor and Professor Conrado Gini as president.

A GIFT of a bio-physical laboratory, costing somewhat over $15,000, has been made by Mrs. Walter B. James to the biological laboratory of the Long Insland Biological Association at Cold Spring Harbor. The laboratory will be known as the Dr. Walter B. James Memorial Laboratory.

THE Thirteenth International Congress of Ophthalmology will be held at Amsterdam from September 5 to 13, under the presidency of Professor van der Hoove, of Leyden.

ACCEPTING a ruling by Assistant Corporation Counsel Samuel Silverman that Harvard College's lease of the Arnold Arboretum was superseded by the right of eminent domain, the Boston city council has passed a measure to appropriate $50,000 and to start construction of the St. Ann Street extension in West Roxbury. The extension will mean the taking of a strip 70 feet wide for a distance of 4,000 feet along the edge of the arboretum. Councilor Henry Parkman is reported to have appealed vainly to defer action until approval had been received from Harvard College, in accord with its agreement with the city.

THE 1929 edition of the National Electrical Code has been declared an approved American standard by the American Standards Association. The code, originally drafted in 1897, has for thirty years been the basic guide for safe practices in the wiring of consumer premises for the use of electricity for light, heat and power. The forthcoming edition is the fifteenth revision of the original text.

THE Bureau of Fisheries will publish shortly a document entitled "Bibliography on Cod-liver Oil in Animal Feeding with Non-critical Comments and Abstracts," by John Ruel Manning, associate technologist of the U. S. Bureau of Fisheries. This document is said to be of interest not only to persons in the fishery industries and producers of cod-liver oil, but also to biochemists and other research workers in this field, and to animal feeders and those interested in animal nutrition in general. It contains as complete a bibliography as could be assembled, together with non-critical comments and abstracts of the references contained therein. The general nutritive and therapeutic properties of cod-liver oil are discussed in detail. The results of experimental feeding of farm animals, as well as the work done with laboratory animals, are included. The manner of administration, the dosages in practical feeding recommended by the best authorities, and many other principles of practice of vital interest to the farmer are set forth.

The British Medical Journal reports that there has come into existence in Belgium a research laboratory and registration bureau whose aims are to assist employers in all branches of industry in choosing new members of all grades for their staffs; to undertake research on matters of practical interest, either for individuals or for industries and commercial organizations; and to instruct students in psychological investigations, qualifying them to carry on practical work under guidance of the laboratory staff. A new publication, *The Review of the Science of Labour*, has also appeared, with the subtitle *Psychological Technique, Organization.* Its scope includes general psychology; the physiology concerned in work; and psychological technique from the professional standpoint, or affecting the selection of workmen, or required in the scientific organization of industry. It deals, in short, with all those questions at issue in the leading industrial countries, most of which have such special journals of their own.

UNIVERSITY AND EDUCATIONAL NOTES

BY the will of Lillie Hitchcock Coit, of San Francisco, the University of California receives the residue of her estate, which will probably amount to $300,000, for the support of the lecture foundation established by her father, Charles M. Hitchcock, in 1872. It is directed that the money be used to increase the endowment of the Hitchcock chair, and that it hereafter be known as the Charles M. and Martha T. Hitchcock Chair, in honor of her father and mother.

A GIFT of £20,000 has been made to the University of Edinburgh by Dr. Thomas Cowan, a Leith shipowner. This gift is in connection with Cowan House, a residence founded by him to be a social center for male students of British extraction. His desire is that the residence should attract young men of intellectual force or other personal characteristics who are likely to have a useful influence on their fellow-students.

DR. SIDNEY BLISS, associate professor of biological chemistry at McGill University, has resigned to accept the chair of biochemistry in the school of medicine of Tulane University of Louisiana, effective September 1.

DR. FRANKLIN C. PASCHAL, professor of psychology and associate dean of the college of arts and sciences of Vanderbilt University, has been appointed dean of the college.

DR. REGINALD D. MANWELL, head of the department of biology in West Virginia Wesleyan College, has been appointed instructor in the department of protozoology of the school of hygiene and public health of the Johns Hopkins University.

PROFESSOR ALLEN MAWER has been appointed provost of University College, London, as from January 1, 1930, in succession to Sir Gregory Foster.

A. W. ASHBY has been elected professor of agricultural economics in the University College of Wales, Aberystwyth.

M. TRAVERS, professor in the faculty of sciences of Marseilles, has been elected professor of industrial chemistry in the University of Nancy.

DISCUSSION

A NOTE ON THE ASSOCIATION OF DISEASES[1]

IT is a question whether any more complicated relations than those of "more" and "less" can ever be really proved by the use of statistical methods alone and unaided, and indeed in not a few cases there is some doubt inhering in a statistical conclusion that A is more than B or C is less than D. Perhaps in the long run it will appear that the chief usefulness of the statistical technique in the methodology of science is the not unimportant one of suggesting problems and lines of attack upon problems which must finally be solved, if they ever are solved, by the application of the methods of experiment and observation, or a close and integrated correlation of these methods with the statistical to reach a common end. It is of interest to note that this is essentially the position taken by Dr. C. A. Gill[2] in regard to the proper place of the statistical method in epidemiological research, in which it has generally been thought to be almost the necessarily preeminent if not exclusive method.

These remarks are occasioned by the consideration of the wider problems which are being opened out by a recent statistical study of the relation between cancer and tuberculosis.[3] It has long been a well-known objective fact of clinical experience that these two diseases are but rarely found together at the same time in florid activity in the same living person. The same objective result has been found in the statistical study of large collections of autopsy records, not alone by the present writer, but by a number of predecessors in this field of investigation. Furthermore, general vital statistics, with perhaps less precision and reliability, lead to the same objective finding. The correctness of this purely empirical objective result has apparently not been questioned by any serious student of the matter.

The difficulty arises, as is so often the case in statistical matters, in the interpretation of the objective findings. Considering generally the association of any two diseases, the objective findings seem bound to fall into one or another of the following three categories, *viz.*, (1) The two diseases are found to be significantly *more* frequently associated together in the same person at the same time than would be expected from the product of the simple probabilities of the occurrence of each alone; (2) The two diseases are found to be associated together in the same person at the same time to *the same* degree of frequency, within the limits of errors of sampling, as would be expected from the product of the simple probabilities

[1] From the Institute for Biological Research of the Johns Hopkins University.

[2] C. A. Gill, "The Genesis of Epidemics and the Natural History of Disease." An introduction to the science of epidemiology based upon the study of epidemics of malaria, influenza and plague. New York (William Wood and Company). 1928. pp. xxvi + 550. See particularly pp. 18–24.

[3] R. Pearl, "Cancer and Tuberculosis," *Amer. Jour. Hyg.*, 9: 97–159, 1929.

of the occurrence of each alone, and (3) The two diseases are found to be significantly *less* frequently associated together in the same person at the same time than would be expected from the product of the simple probabilities of the occurrence of each alone.

Now, as has been pointed out above, the experience of clinicians, pathologists and statisticians over the last three quarters of a century indicates that cancer and tuberculosis appear to fall into category (3) in respect of their association. At the same time it is equally well known that occasionally the two diseases *may* occur in florid activity in the same person at the same moment.

There are at least two possible interpretations of this situation. Stated in the briefest way, one is that the reason why cancer and tuberculosis are not more frequently associated in active form is because there is some wholly unknown sort of "antagonism" or incompatibility between the two diseases. The other is that the result is purely fortuitous, the infrequency of association arising from the assumed fact that the time relations of the disease between onset and death are such as to make impossible the complete freedom of joint association which is an implicit postulate of the simple probability theory. Or putting the point less formally, it can be alleged that the reason why persons with cancer are clinically found to have florid tuberculosis less frequently than persons without cancer (of the same age, of course) is because the cancer kills them before there is time for florid tuberculosis to develop. And *mutatis mutandis* the argument may be made the other way about.

So far as evidence has yet developed there appears to be no way of determining conclusively which of these alternative interpretations of the objective findings is the true one. In the paper referred to above[4] the first interpretation was adopted because the weight of all the evidence available seemed to point in that direction. This interpretation may have been erroneous. If so, the fact will doubtless be developed as further evidence comes to hand. It should be said, however, that a considerable element in leading to the adoption of the "antagonism" interpretation was derived from biological rather than statistical considerations, particularly from the study of the clinical histories, while they were living, of the individuals included in the autopsy material, on the one hand, and from the study of the course of the two diseases in each individual as revealed in the autopsy findings themselves, on the other hand. Many diseases, and particularly cancer and tuberculosis, leave in the body a record of their development and course from which there can be reconstructed a picture of the events long prior to death.

[4] R. Pearl, *loc. cit.*

Investigations which have been made since the publication of the statistical paper have tended to strengthen the opinion that the interpretation adopted was the correct one. These have been chiefly along two lines: (*a*) a very careful and detailed study, from the original material, of the cases in the Johns Hopkins Hospital autopsies in which both cancer and tuberculosis occurred together in florid form. These studies have been made by Dr. W. T. Howard, Jr., a pathologist of long and wide experience. The results will presently be published in detail. (*b*) The results of treating cancer experimentally with tuberculin, regarding which a preliminary report[5] has already been published. A detailed report will follow in due time. Both these lines of investigation appear to indicate that the products of metabolism of the tubercle bacillus, if present in sufficient amounts, have a definite and marked effect upon the characteristics of at least certain types of malignant cells.

But the question of the association of diseases is a much broader one than that merely of these two. We are now investigating the association of a considerable number of important pathological conditions, such as diabetes, nephritis, various heart diseases, arteriosclerosis, etc., both among themselves and with cancer and tuberculosis. It is hoped that such a comprehensive study may help to throw light upon the correct interpretation of the statistically infrequent association of these two, in addition to its own intrinsic interest.

RAYMOND PEARL

JULY 25, 1929

PARTHENOGENESIS AND POLYEMBRYONY IN ALNUS RUGOSA (DUROI) SPRENG.

Alnus rugosa is polymorphic. Plants exhibiting such variability usually furnish material which is of interest cytologically, in so far as the reproductive cells are concerned. Due to irregularities of microsporogenesis, pollen formation in this alder produces only 2 or 3 per cent. of morphologically perfect pollen.[1] Although thousands of ovaries at various stages of development have been examined microscopically, no pollen tubes have been seen.

The plant, however, sets an abundance of viable seed. When seed-producing catkins are so bagged that pollination can not take place, embryos are formed in the ovules just as under normal conditions. Germination tests of normally formed seed and of bagged seed proved equally successful in seedling production.

[5] R. Pearl, A. C. Sutton and W. T. Howard, Jr., "Experimental Treatment of Cancer with Tuberculin," *Lancet*, May 25, 1929, p. 1078.

[1] R. H. Woodworth, "Cytological Studies in the Betulaceae. II. Alnus and Corylus," *Bot. Gaz.* (in ed.).

Normally the number of chromosomes is reduced by one half when the embryo-sac mother cell divides. In *Alnus rugosa* there is no such reduction. The pairing of homologous chromosomes does not take place so the embryo-sac initial has the sporophytic or diploid number of chromosomes, twenty-eight.

From one to four embryo-sacs may form in one ovule from as many embryo-sac mother cells. Embryos arise in these embryo-sacs from the diploid egg, which, of course, has not been fertilized (parthenogenesis) and by budding of the nucellus. Well-developed embryos appear to have had their origin in the synergids and the antipodals. Such embryo formation would be cases of apogamy. Several very interesting preparations suggest the origin of certain embryos from the endosperm. One ovule, in particular, has an embryo from the diploid egg and another embryo forming in a massive endosperm, being completely surrounded by it and bearing a suspensor, the cells of which merge into the endosperm material. Serial sections show that this embryo is not connected with the nucellus at any point. The initial stages in embryo formation from synergids, antipodals and endosperm have not yet been observed.

One to five embryos may mature in one embryo-sac. Several embryos may mature in each of two embryo-sacs in the same ovule. Germination tests show that two embryos from the same seed can both develop to normal seedlings.

Polymorphism, irregular mioses, parthenogenesis, apogamy, nucellar budding and polyembryony all point to a hybrid origin for *Alnus rugosa* of the New England region.

ROBERT H. WOODWORTH
HARVARD UNIVERSITY

A BOMBARDING DICAELUS BEETLE

I AM writing concerning an experience that I had with a ground beetle on November 3, 1928. While the Pi Chapter of Phi Sigma was having a picnic at Stone Mountain, several of the members were collecting various specimens. I turned over a rock and picked up a species of Dicaelus, and while I was holding it between my thumb and forefinger and using the other fingers to unscrew the cap from the cyanide bottle, it gave off a very strong discharge of gas which turned to a dense smoke. This appeared to come from the anterior end of the beetle, instead of from the posterior end as in the genus Brachynus. I placed it head first into the bottle, when it gave off another discharge, which also appeared to come from the side of the head. The bottle was filled so densely with this smoke that the beetle was almost entirely hidden; when I took off the cap to show several of the party, the smoke escaped to a distance of over a foot from the bottle. I am very anxious to hear from any reader of SCIENCE that has had a similar experience with a beetle of the genus Dicaelus. I have known several Brachynus beetles to discharge the gas, which always appeared to come entirely from the posterior end of the body.

P. W. FATTIG
EMORY UNIVERSITY, GEORGIA

QUOTATIONS

THE SEVENTIETH BIRTHDAY ANNIVERSARY OF THEOBALD SMITH

ANNIVERSARIES play an important part in national life as they do in one's personal experiences. They serve not only to arouse retrospect and encourage a review of what has gone before, but also to awaken an interest in the impending possibilities of the future. The experience of the past tends in no small measure to kindle new enthusiasms for what coming years may reveal, or to dampen an ardor for plans and projects that history has indicated to be futile or unlikely to be accomplished. It has become customary to select the centennial anniversary of the accomplishment of some notable purpose or the birth of a distinguished person for the celebration of achievement and the review of its significance and bearing on progress. It seems equally fitting at times to refer to significant contributions before their consequences have become so familiar that the merits of the maker are all but forgotten.

The seventieth birthday anniversary of Theobald Smith, at the time of his announced retirement from the active directorship of the Department of Animal Pathology of the Rockefeller Institute at Princeton, N. J., affords a welcomed opportunity to hail one of the eminent American contributors to the advancement of science and the development of medicine. The demonstration of the existence of insect vectors in the transmission of disease—a phenomenon that the medical student of to-day, only a generation after the epoch-making discovery, accepts without debate or hesitation—marked Smith as one of those rare pioneers who sense great opportunities, who see what others have persistently failed to observe, and who have the strength and courage to give force to their convictions.

A popular writer has remarked that it was Theobald Smith who made mankind turn a corner. "He was the first, and remains the captain of American microbe hunters," showing men an entirely new and fantastic way in which a disease may be carried—by an insect. It is fortunate as indeed it is gratifying that with the progress of popular education the significance of such a discovery may to-day be thoroughly appreci-

ated by thinking people and that they may share in expressions of congratulation and the heralding of well-deserved honors. Thus, in reviewing the achievement of the unostentatious investigator on the scientist's birthday, the New York *Times* has offered this editorial tribute:

> A world accustomed to accept such facts as the communication of disease by insects can scarcely appreciate the significance of Dr. Smith's discovery in 1893 of the transmission of the so-called Texas fever of cattle from one animal to another by means of ticks. For seven years he had been experimenting with this disease, and discovered that it could be carried even by ticks which had never been in contact with infected cattle, but which had acquired the virus from their parents. This opened up an entire new field of thought and lent moral courage to those who made the test which finally proved that yellow fever was transmissible by certain types of mosquitoes. In like manner the connection between the spread of malaria and mosquitoes was discovered, and between sleeping sickness and the tsetse fly.
>
> Dr. Smith's achievements are by no means completely covered by reference to his studies of Texas fever in cattle and all that this implies. He was among the earliest students of the phenomena that are now designated by the comprehensive term anaphylaxis—mysterious manifestations that are concerned in the genesis and the control of many maladies of mankind. But this is not a review. American medicine—indeed, the scientific world and the layman as well—rejoice in recalling the part that Theobald Smith has played in the advancement of learning and the promotion of human and animal welfare.—*The Journal of the American Medical Association.*

SCIENTIFIC BOOKS

Incomes and Living Costs of a University Faculty. Edited by YANDELL HENDERSON and MAURICE R. DAVIE. Yale University Press. 1929.

THIS admirable report on the academic standard of living, based on adequate returns of a representative community, takes the question out of the sphere of "academic" discussion into that of statistical evidence. It does not stand alone. There is the similar study by J. B. Peixotto for the University of California, and the General Education Board has collected data of a wider range though less complete. The conclusions of all are closely in accord so far as the bearing of condition upon desirable provisions go. The day is past when one can speak casually or earnestly of the underpaid professor and let it go at that. The problem of the colleges and universities in the United States is a very complex one; serious influences of many-sided origin are in operation making unmistakably for decline. The blind optimism and complacent acceptance of mediocre standards and still more the bid for popularity under the pressure of unenlightened influence in their combination is itself one of them. Consequently the redemption of the universities by providing adequate incomes on a just scale of compensation is but a partial solution of a grave situation. Yet it is in itself so vital, so definitely critical to one phase of the academic maladjustment that its importance is convincing.

Selecting the practical issues rather than the statistical basis for them as a basis of comment, we are understating the case in saying that the average member of the Yale faculty—doubtless more fortunately situated than the average member of high-grade faculties in general—has about half the income necessary to maintain himself and his family in comfort and security and enable him with reasonable freedom from care to devote his energies whole-heartedly to his profession. The very paradox of the situation appears in the statement that only by "excessive curtailment of the budgetary needs" can the college professor "buy for his children such education as he and his colleagues produce." The ultimate and actually operative effect of this situation is that high-grade men are dissuaded from entering what should be a high-grade profession; the quality of the personnel of even the best-manned faculties (certainly of all but the very best) is declining. The promising candidate for the academic life may now read in these objective statistics about what he may expect if he decides to trust his fate to university conditions. Unless his youthful enthusiasm places himself in the rôle of the very few who escape the common lot of the barely successful professor, or he finds himself with some private means to offset the struggle, he may well decline the venture, however enthusiastic his devotion to learning. He is likely to be guided in his decisions by comparison with the economic position of other high grade professional callings; the statement that "the American university teacher in many cases lives essentially as do men of the skilled mechanic class" is discouraging even to one who has a high regard for mechanical skill and no more snobbery than is democratically acceptable. There are professional standards of self-respect that are socially reflected; there are limits to the correlation of high thinking and plain living.

Viewed more closely, the first effect of this condition, which may be described as poverty mitigated by a salary (this for the less well-adjusted institutions) is the pressure upon members of university faculties to earn additional income. Though in some cases that supplementary earning is helpful to the professor and brings some prestige to his institution, by far the greater amount of it is pot-boiling, and the statistics show that most of the men thus earning something to eke out their income earn mighty little—the pot doesn't even boil, is just kept lukewarm. It is only the more fortunate (usually by reason of the nature of their specialties or a popular demand) who earn enough to leave a balance in the bank. The professor is nominally a full-time professor, but he is not a full-energy professor if his chief consideration outside his teaching is not self-advancement but any sort of remunerative work. Quite in the same import is the dismal statement of how few of the academic families can afford a servant or even such occasional service as would ease the strain on energies. The public would have a fairer view of the professor if they thought of him more commonly not in his lecture room or laboratory but in his household; they would find the most considerate of the group doing anything but academic work to save the excessive drudgery that otherwise would fall upon their college-bred wives.

Touch the situation where you will—and the data are here for all essential details—where the professor lives, how he lives, what he spends his money for, how he is forced to spend his time, what he finds when he compares himself with other high-grade callings—and the same story of inadequacy appears, the same crippling of energies, the same sense of insecurity. "The difference of a few thousand dollars in salary [for simpler academic communities than Yale one thousand would often be adequate] makes the difference between an anxiety that lowers efficiency and tends to dissipate energy in outside activity, and that feeling of safety and enfranchisement in the pursuit of a life interest that increases efficiency by concentrating energy and effort." The economic redemption of the professor is the indispensable step to increasing the attractiveness of the profession and thereby the quality of the personnel upon which all other academic values depend.

The responsible authors of the report have done well to include in it a discussion of the academically vital matter of how salaries, now in their inadequacy and later when endowments flow in an approximate redemption, shall be determined. For here is a serious maladjustment for which not the public or private support but the academic policy is to blame. Three systems are recognized: (1) a fixed uniform salary rate; (2) individual bargain not controlled or imperfectly so by a fixed schedule, and (3) a scale increasing with rank and service. As a fact, actual systems are composites, often temporizing ones. The report wisely concludes that "the weight of the argument bears heavily against the plan of the individual bargain and in favor of the fixed salary scale, based upon rank and length of tenure within the rank," all, however, on the assumption that the salary scale is itself adequate. The conclusion might well have been more strongly put. Individual bargaining has done more havoc to academic ideals than is easily recorded; the resort to it shows a low academic morale, however strong the temptation. Assenting to the conclusion one may add the further practical policy of equalizing salaries all the way along to make as few distinctions in rank and salary as possible. Competition among professors for salary, indeed any attempt to measure individual merit or service by salary, should be definitely discouraged. Salaries should be adequate and then forgotten. Salaries are adjusted to supply needs, as this report ably sets forth; they can not also be used as rewards of merit. One can not serve two masters, and part of the compensation of the academic life is a reasonable freedom from competition.

Authorities are impressed by printed documents and the evidence of careful research, and in this instance properly so. This investigation was undertaken by the Yale Chapter of the American Association of University Professors, and to them the academic public is indebted for a service which is likely to bring some measure of relief. The obstacles are serious, doubtless more so in state universities where different influences prevail and in the smaller colleges where standards of living are deplorably low, as deplorably intellectually as economically. The aspirant for an academic career is far more likely to land in some isolated college town than in New Haven; it would be well to complete the picture by a similar survey of the average college community. The conclusions would be still more discouraging.[1]

JOSEPH JASTROW

[1] A matter of special moment to the professor is the provision for the future. This is touched upon only by way of the item of life insurance. It is plain that the professor is inadequately insured. The provision for retiring allowances is an integral part of the question of compensation. The failure of the Carnegie Foundation is nothing short of an academic disaster, and the manner of its bringing about, the speciousness of its defense, an aggravation. It now becomes a part of the policy of every enlightened university budget to include a workable system of retiring provisions. The fact that the Carnegie Foundation is willing to pay the overhead expenses of an insurance system should be gratefully acknowledged and universities may be able to utilize that provision as part of a more adequate system. To regard the so-called substitute plan of the Carnegie Foundation as a solution of the retiring allowance problem would be misleading.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A SAFETY RAZOR BLADE WHICH CUTS AS WELL AS THE BEST MICROTOME KNIVES

LABORATORY instruction in histologic and cytologic technique very often taxes the patience of the teacher when students abuse apparatus, especially the microtome knives. If a limited number of knives are used, students become careless and knives are soon dulled or nicked. Better results are obtained by assigning one knife to a small group. A still more satisfactory procedure is to let each student have one knife and burden him with the responsibility of keeping it in good condition. This, however, has the disadvantage that a great number of knives must be on hand, and that they have to be resharpened at the end of the course.

Recently, a new safety razor blade made its appearance, which is radically different from older types. It is curved and heavier than the ordinary blade. The curvature adds to its inherent strength, so that it is practically impossible to bend it. I tried this blade by attaching it to a piece of hard wood and was able to cut sections of four microns of Drosophila eggs without having the slightest variation in thickness. I communicated with the company which manufactures these blades, asking for the production of a holder, so as to be able to use the blades for general microtome work. After several conferences with the technical expert, I obtained a steel holder with the blade attached in the center. This curved safety razor blade with its holder gave me as good results as any knife I ever used. The blade is rigid, giving uniform sections of any thickness. It stands up under its own strength, being attached to the holder by only two screws. It is concave, approximating the best microtome knives on the market.

I requested the company to submit this product to all of us who for so many years have been looking for salvation from the troubles of microtome knives. I have been told that the holder will soon be advertised and introduced to the readers of SCIENCE.

ALFRED F. HUETTNER
WASHINGTON SQUARE COLLEGE,
NEW YORK UNIVERSITY

ANOTHER PETROGRAPHIC METHOD

THERE appeared in SCIENCE for April 5 a note by Charles Milton on microscope technique of especial interest to petrographers. It dealt with the use of the analyzer frame in determining refractive indices of powdered minerals under the microscope. That note suggests another. The Leitz Company has added to its standard petrographic microscope a special substage shader, the purpose of which is to give better results in determining refractive indices by the inclined illumination method. There are many who prefer the inclined illumination method to any other though it may not be any more accurate or convenient. The shader consists of a small plate on a swinging arm controlled by a convenient lever. It swings in below the condensing lens and above the polarizer. The intensity of the illuminated or darkened margins of grains is very satisfactory indeed both with white and diffused monochromatic light and a high degree of accuracy is afforded. It is of course much more convenient than the use of the finger or a card. The shader has been developed by W. Zieler, of the Leitz Company in New York City. It is announced by the writer at the request of Mr. Zieler.

R. C. EMMONS
GEOLOGICAL LABORATORIES,
UNIVERSITY OF WISCONSIN

SPECIAL ARTICLES

A METHOD OF DETERMINING THE AXIAL RATIO OF A CRYSTAL FROM X-RAY DIFFRACTION DATA: THE AXIAL RATIO AND LATTICE CONSTANTS OF ZINC OXIDE

AN X-ray diffraction pattern taken by the powder method gives directly the interplanar spacings of the most important planes. In the case of a hexagonal or tetragonal crystal most of these spacings are dependent on both "a" and "c," which are the lattice parameters along the X (or Y) and Z axes respectively. Only a few of these spacings are dependent on either "a" or "c" alone. An accurate determination of the axial ratio could not be made by direct calculation from these few spacings.

A graphical method of finding the axial ratio from a group of interplanar spacings has been developed by Hull and Davey.[1] It is evident to any one who has used this method that it is only approximate. Since the values of "a" and "c" can not be calculated without knowing the axial ratio, it is necessary, for any accurate measurement of the lattice parameters of a crystal, to know the axial ratio accurately.

A very accurate method of finding the most probably correct value of "a" for cubic crystals, from a series of observed interplanar spacings, has been described by Davey.[2] The method consists of plotting on arithmetic probability paper[3] the values of "a," calculated from the observed interplanar spacings,

[1] A. W. Hull and W. P. Davey, *Phys. Rev.*, 17: 549, 1921.
[2] W. P. Davey, *General Electric Review*, 29: 118–128, 1926.
[3] A. Hazen, *Trans. Am. Soc. C. E.*, 77: 1539, 1914.

against the per cent. of the values that are equal to or smaller than their respective values. Since the calculations are ordinarily made by means of logarithms it has been found to be a convenience in actual practice to plot the logarithms of "a" instead of the actual values calculated for "a" from each of the interplanar spacings. Davey found that the degree of reproducibility of measurements on an X-ray pattern was such that when eight or more values were considered the probability curve was a straight line between the 30 and 70 per cent. points. The value of log "a" at the 50 per cent. point is taken as the most probably correct value.

At the suggestion of Dr. Davey this method was adapted to finding the axial ratio of a hexagonal crystal. The axial ratio is found approximately from the charts of Hull and Davey.[1] A group of seven or eight values approximating this axial ratio is selected and, for each of these axial ratios, values of log "a" are calculated from each of the observed interplanar spacings.

The values of log "a" for each axial ratio are plotted on probability paper according to the method of Davey, one curve for each axial ratio. That curve based on the most probably correct axial ratio will be closest to being a straight line. All others either side of it will be progressively farther from being a straight line because that curve whose points are calculated in terms of the true axial ratio will be the nearest approach to a true probability curve. On this type of plotting paper this is a straight line. The value of log "a" can be read directly from the 50 per cent. point of the curve based on the true axial ratio.

The sensitiveness of the method is illustrated below in the case of zinc oxide. The zinc oxide used was made by H. M. Cyr and L. M. Andreuzzi, of this laboratory, by burning spectroscopically pure zinc in air. C. C. Nitchie, also of this laboratory, tested the specimen on the quartz spectrograph and found it to contain only very faint traces of impurities. The General Electric X-ray diffraction apparatus was used in making the X-ray patterns.

TABLE I

Planes	Spacings
10.2	1.908
11.0	1.622
10.3	1.474
11.2	1.376
20.1	1.352
20.3	1.090
12.1	1.038
10.5	0.974
12.3	0.904

Table I gives the average observed interplanar spacings, taken from three films, which were used in the final calculations.

The Hull and Davey charts give an axial ratio of 1.61 from these data, hence a series of axial ratios from 1.606 to 1.613 was selected for the calculations. The curves plotted from these data are shown in Fig. 1. The origin of coordinates is shifted for each curve

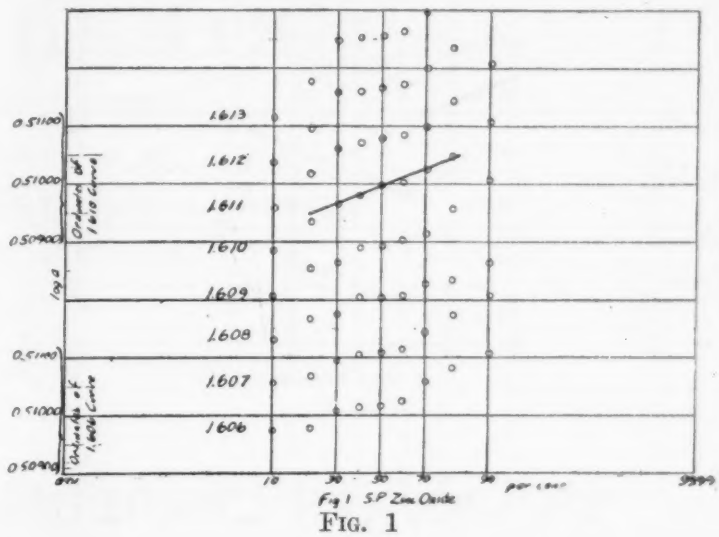


FIG. 1

in order to avoid overlapping of the curves. The ordinates for two of the curves are indicated on the figure. There is no doubt that the points of the 1.610 curve come closest to being in a straight line. The value of log "a" at the 50 per cent. point of this straight line will give the most probably correct value of "a."

The unit cell dimensions of zinc oxide of extremely high purity are, therefore, $a = 3.235 \pm .003$ A $c = 5.209 \pm .005$ A $c/a = 1.610 \pm .001$. This value of the axial ratio is slightly higher than the value 1.608 accepted by Bragg[4] and by Weber[5] and considerably higher than the value 1.596 obtained by Barth.[6]

The sensitiveness of the method seems to depend upon the number of values of log "a" plotted on each

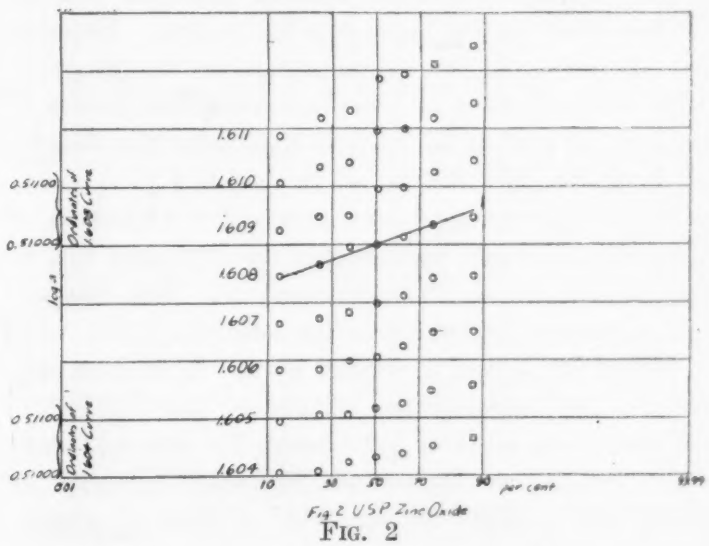


FIG. 2

[4] W. L. Bragg, *Phil. Mag.*, 39: 647, 1920.
[5] L. Weber, *Zeit. f. Krist.*, 57: 398–403, 1922.
[6] Tom Barth, *Norsk Geol. Tids*, 9: 317–319, 1927.

curve. This may be illustrated by the data of Figs. 2 and 3. Fig. 2 shows curves plotted from seven observed values of interplanar spacings of U.S.P. zinc oxide (a grade of zinc oxide less pure than that made from spectroscopically pure zinc). Fig. 3 shows curves plotted from thirteen interplanar spacings observed on a sample of wurtzite (hexagonal zinc sulphide). The correct value of axial ratio for the U.S.P. zinc oxide is probably $1.608 \pm .002$ and for the wurtzite $1.636 \pm .001$.

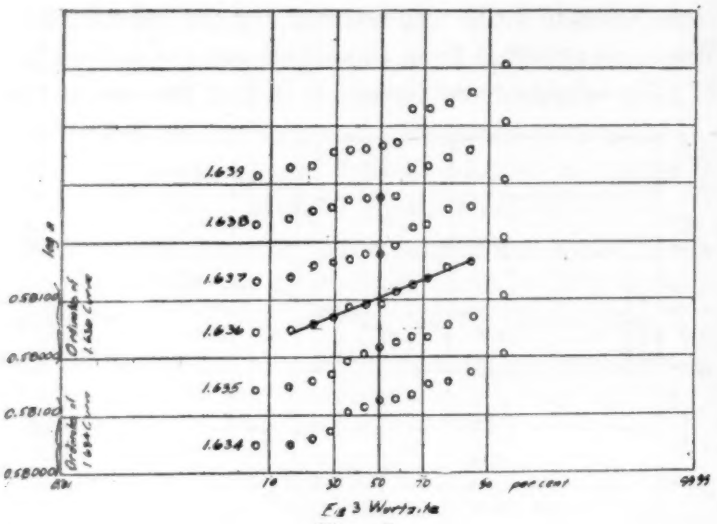


FIG. 3

The experimental work on U. S. P. zinc oxide was done by P. van Dyck, formerly of this laboratory. The complete data on wurtzite will be published elsewhere.

The author wishes to express his appreciation to those members of this laboratory, mentioned above, who cooperated with him in the work on zinc oxide, and to Dr. Wheeler P. Davey, of the Pennsylvania State College, who originally suggested this method of determining axial ratio.

M. LUTHER FULLER

RESEARCH DIVISION,
THE NEW JERSEY ZINC COMPANY,
PALMERTON, PENNSYLVANIA

THE NORTH CAROLINA ACADEMY OF SCIENCE

THE twenty-eighth annual meeting of the North Carolina Academy of Science was held at the North Carolina College for Women, Greensboro, N. C., on May 10 and 11, 1929. Papers were presented before the general section of the academy on Friday morning and afternoon. Friday evening the retiring president, State Forester J. S. Holmes, gave his presidential address on "A State Forest Policy for North Carolina." This was followed by a talk from Dr. E. W. Gudger, of the American Museum of Natural History, a past president of the academy and the secretary-treasurer of the academy from 1908 to 1918. Dr. Gudger was given quite an ovation by the academy and his presence added much to the enjoyment of the meeting. Saturday morning the academy met in the following sections: general section, chemical section, mathematics section and physics section. Seventy-four papers and five exhibits were on the program. (Abstracts of most of these and complete papers of several will appear in an early number of the *Journal of the Elisha Mitchell Scientific Society*.)

The executive committee reported the election of forty-two new members during the year and the reinstatement of six former members. Two hundred and seventeen registered at the meeting.

Miss Lila Aaron, a student of the Lexington high school, was declared the winner of the high-school science prize, a silver loving-cup, for the best essay submitted by a high-school student. (Essays for 1929 were confined to the fields of biology, geology and geography.)

The officers elected for the year 1929–30 were:

GENERAL ACADEMY

President, J. B. Derieux, State College.
Vice-president, J. B. Bullitt, University of North Carolina.
Secretary-treasurer, H. R. Totten, University of North Carolina.
Executive committee, the above officers and W. C. George, University of North Carolina; F. A. Wolf, Duke University, and Bert Cunningham, Duke University.
Representative to the A. A. A. S., W. C. Coker, University of North Carolina.

CHEMICAL SECTION

Chairman, Frank K. Cameron, University of North Carolina.
Vice-chairman, O. J. Thies, Jr., Davidson College.
Secretary-treasurer, L. B. Rhodes, North Carolina Department of Agriculture.
Councilor, F. W. Sherwood, State Experiment Station.

MATHEMATICS SECTION

Chairman, Helen Barton, North Carolina College for Women.
Secretary, W. W. Elliott, Duke University.

PHYSICS SECTION

Chairman, Otto Stuhlman, Jr., University of North Carolina.
Secretary, G. B. Collins, Duke University.

The twenty-ninth annual meeting of the North Carolina Academy of Science will be held at Duke University, Durham, N. C., in the spring of 1930.

H. R. TOTTEN,
Secretary

Coming Soon

a new third edition of

Principles of
ANIMAL BIOLOGY

By A. FRANKLIN SHULL

With the collaboration of

GEORGE R. LaRUE and ALEXANDER G. RUTHVEN

of the University of Michigan

$3.50

McGraw-Hill Publications in the Zoological Sciences

IN this new edition the authors reaffirm their conviction that the best approach to biological science is through the presentation of great generalizations and fundamental principles.

The intimate relation between function and structure is emphasized by combining the chapters on morphology and physiology of higher types. The combined discussion is divided into several chapters in recognition of distinct types of physiological processes.

The account of cell structure and cell physiology has been rewritten to emphasize still more strongly the fundamental features, and to include some of the most recent conclusions of the general physiologists.

The chapter on Genetics has been strengthened by the inclusion of an adequate account of linkage and sex-linkage, by revision of the problems and by the inclusion of additional problems.

The entire book has been thoroughly revised to reflect new discoveries and altered points of view.

Shull's PRINCIPLES OF ANIMAL BIOLOGY has been widely used in previous editions. In fact this past year it has been in use in 87 colleges.

A revision of Shull's LABORATORY DIRECTIONS IN ANIMAL BIOLOGY is also in press.

Send for a copy on approval.

McGraw-Hill Book Company, Inc.

370 Seventh Avenue Penn Terminal Building New York

SCIENCE NEWS

Science Service, Washington, D. C.

PAPERS READ BEFORE THE INTERNATIONAL CONGRESS OF PHYSIOLOGY

ERGOSTEROL, the stuff that gives certain fats and oils their power to prevent rickets when irradiated with ultra-violet light, has been split chemically into two related compounds. One of them retains the old name ergosterol, and the other is called isoergosterol. By highly refined chemical treatment the latter compound can be obtained in an extremely pure state. A mixture of ergosterol and isoergosterol exposed to ultra-violet light behaves in very much the same manner as natural ergosterol, so far as the spectroscope discloses; yet this synthetic mixture failed to prevent rickets in a group of experimental animals, according to experiments performed by Doctors C. E. Bills, E. M. Honeywell, W. M. Cox, Jr., and A. M. Wirick, of Evansville, Indiana. The experimenters conclude that a spectroscopic study of ergosterol can not yet be relied upon to give an index to the curative power of any given sample, but that experiments with animals must continue to be made. They also found that the length of time needed to give ergosterol a certain curative strength varies according to the substance in which it is dissolved. Moreover, the solvent need not be transparent; arachis oil, the one used commercially, is not transparent yet permits a high degree of activation. A further discovery is that activated ergosterol is remarkably non-poisonous. Quantities from 4,000 to 40,000 times as large as the therapeutic dose have been fed to rats before physiological disturbance resulted.

THE soy sauce of China aids digestion, according to Dr. A. A. Horvath, of Princeton University. It contains a number of ferments and other substances stimulating to the digestion of starches and protein and the adsorption of food generally. The soy bean, which is a universal article of diet in China and other countries of the Orient, is the only seed which contains both water-soluble and fat-soluble vitamins. It has the additional advantage of containing a rather large proportion of the vitamin that promotes fertility.

THE brain of an animal suffering from a lack of vitamins resists this particular type of starvation more successfully than the rest of the body. This is indicated by experiments reported by Dr. J. Mosonyi, of Budapest. Dr. Mosonyi selected three groups of white rats as the subjects of his experiment. He gave one group an ordinary diet, with neither excess nor lack of vitamins. A second group got a ration as near to zero in vitamin content as can be devised, while the third received a considerable excess in vitamins. At the end of the experimental period the brains were weighed. There was no notable difference in weight. This is taken to indicate that an excess of vitamins does not make for any notable increase in total brain size, and that in animals whose bodies are rendered subnormal by vitamin starvation the brains are still able to grow to normal size. Although the excess-vitamin diet did not benefit the rats' brains quantitatively, it appears to have had some effect on their chemical make-up, for the nitrogen content of the excess-vitamin rats' brains was noticeably higher than that of the brains of their brothers kept on a "normal" diet.

DR. K. H. CONARD, K. M. Key and B. G. E. Morgan, of London, have tested the effects of a vitamin-free diet, supplemented by measured amounts of vitamin-containing material, on young rats. They found that on one combination, containing an adequate concentration of the necessary growth-promoting vitamin A, their animals nevertheless failed to show normal growth. But when the diet was altered to include a commercial protein material known to physiologists as "light-white casein," growth was as it should be. The new growth factor is still unidentified, but it has been possible to extract it from the "light-white casein" by suitable chemical treatment; and it has also been proved present in lettuce, wheat embryo, milk, grass and a number of other plant and animal foods.

A POSSIBLE connection between anemia and one type of "stomach trouble" was pointed out by Dr. W. N. Boldyreff, of Battle Creek, Michigan. It is one of the best known of physiological facts that the juices of the stomach are highly acid, while those of the small intestine are less acid and finally alkaline. It is also known that red blood-cells are destroyed by acid; this fact was established by experiments in test-tubes, but had never been confirmed by observations on living animals. The possible connection suggested itself to Dr. Boldyreff, and he induced his associate Ephraim Boldyreff to make tests in his laboratory. Acids were introduced into various parts of the digestive tracts of several dogs over a period of some weeks. In all cases it was apparent that the acids were being absorbed through the intestines into the blood-stream, and the count of red blood-cells fell off markedly, giving rise to a condition resembling pernicious anemia. When the acid was no longer administered, the blood of the dogs returned to normal after a few weeks.

THE more butter, bacon and other forms of fat there are in your diet, the less need of vitamin B, the dietary factor that wards off beriberi and similar deficiency diseases, according to a report made by Professor Herbert M. Evans and Dr. Samuel Lepkovsky, of the University of California. Experimental animals on a diet of table sugar and casein, the essential protein of cheese, need considerable quantities of vitamin B. If 10 per cent. of fat is added the vitamin B requirement is lowered, and if the percentage of fat is raised to an even 50, the animals will live for six months without any sign of beriberi, even when deprived of the vitamin.

DR. REUBEN L. HILL, nutrition expert of Logan, Utah, has developed a test at the Utah State Experiment Sta-

The Wistar Institute Bibliographical Service

is of invaluable assistance to

Librarians—Investigators—Teachers

It brings to them, in AUTHORS' ABSTRACT form, a brief review of all original papers on Biological Subjects which appear in the following journals:

Journal of Morphology and Physiology
The Journal of Comparative Neurology
The American Journal of Anatomy
The Anatomical Record
The Journal of Experimental Zoology
American Journal of Physical Anthropology
The American Anatomical Memoirs
Folia Anatomica Japonica (Tokio, Japan)
Stain Technology (Geneva, N. Y.)
Physiological Zoology (Chicago, Ill.)

Advance Abstract Sheets

issued semi-monthly, bearing Authors' Abstracts without bibliographic references, offer a practical means of making research immediately available in abstract form and of purchasing articles of special interest in reprint form without the necessity of subscribing to all the journals. Subscription, $3.00 per year.

Bibliographic Service Cards

with complete bibliographic references, printed on Standard Library-catalogue cards, are of value and assistance to Librarians and Investigators. Subscription, $5.00 per year.

Abstracts in Book Form

referred to above, are brought together periodically, with Authors' and Analytical Subject Indices. Price $5.00 per volume.

Subscriptions to the Bibliographic Service and orders for reprints should be sent to

The Wistar Institute of Anatomy and Biology
Thirty-sixth St. and Woodland Ave. Philadelphia, Pa.

BIOLOGICAL SUPPLIES

Zoological
Embryological
Botanical Materials
Drosophila Cultures

Groups
Slides
Life Histories
Philippine Land Shells

A Good Book on Seashore Ecology. Verrill's Vineyard Sound Report. $3.00.

Catalogs will be sent on request
Address all correspondence to

Geo. M. Gray, Curator
Supply Department

Marine Biological Laboratory

Woods Hole, Mass., U. S. A.

LIVING BULLFROGS

Safe delivery guaranteed

Teach Biology with live specimens where practicable

We have the only complete live materials establishment in America. Live plants and animals representing all types are kept on hand under semi-natural conditions at all seasons.

Also headquarters for preserved specimens of all types, microscopic slides, life histories, demonstrations, osteological preparations, insect collections. We specialize in many important southern species not obtainable elsewhere.

All material guaranteed without reservations.

SOUTHERN BIOLOGICAL SUPPLY CO., INC.,
Natural History Building, New Orleans, La.

OUTFITS ENGINEERS. EXPLORERS CAMPERS

Mirakel, Zeiss, Hensoldt and other high-grade Binoculars, genuine Prism, **from $16 to $365.00,** and **Scientific Instruments.**

"FIALA MINIATURE" —new improved 8 x 24; weighs 10 oz.; aluminum metal frame, very strong; guaranteed. Considered the finest all around glass ever produced for size and weight **$34**

Fiala Patent Sleeping Bags and Suits; Imported and Domestic Shotguns, Rifles.
Send for complete catalog "A"

FIALA OUTFITS INC. 25 WARREN ST NEW YORK

JAGABI RHEOSTATS—

wound on *porcelain* tubes instead of porcelain enameled iron tubes, have high insulation and low inductance. They meet an ever increasing demand by Educational, Research and Industrial Laboratories for better and more rugged Jagabi Rheostats. *Write for new Catalog 1230-S listing 57 standardized ratings, which are carried in stock.*

JAMES G. BIDDLE, 1211-13 ARCH ST., PHILADELPHIA

Use Hoke *reducing valves with your hydrogen, oxygen and other gases. Ask for folder S-3.*

Hoke Incorporated **22 Albany St., New York City.**

PYREX **LABORATORY WARE**

Write for literature

CORNING GLASS WORKS, Dept. 75
Industrial and Laboratory Div., Corning, N. Y.

tion by which the toughness of the curd formed by the normal coagulation of milk can be measured. There is reason to believe that this quality of toughness in milk curds is a more important factor in choosing baby's milk than the fat content, previously the item most stressed in picking out suitable infant's food. Not more than ten per cent. of cows, according to the tests made by the investigator, give milk with curds soft enough for delicate babies to digest. By the use of the new curd test it is possible to find cow's milk that closely approximates mother's milk, an invaluable asset for young and sickly babies that have to be fed by a bottle. Such milk, he added, when fed to infants, requires little if any modification or dilution, a condition that does away with the troublesome mixing of the complicated formula on which many modern babies get their start in life.

THE question as to whether a white man can live on meat alone and remain healthy has again been given a critical scientific test and decided in the affirmative, by Dr. E. F. DuBois, W. S. McClellan, H. J. Spencer and E. A. Falk, of the Cornell University Medical College. Two Arctic explorers were kept under observation for the period of a year, during which time they ate nothing but meats of a number of varieties, and drank nothing but meat broths, black tea and water. During the first month of the experiment the men lost five or ten pounds apiece, but after that their weight remained constant. Increased blood-pressure, the traditional consequence of a high meat diet, did not develop; neither did the kidneys show any evidence of damage. There were no signs of lack of vitamins or any other injurious results. The men remained physically and mentally normal throughout.

INSULIN is given to diabetic patients for the purpose of reducing the dangerous concentration of sugar in the blood; yet the first effect of an insulin injection is to increase the amount rather than decrease it. Professor Max Buerger, of the University of Kiel, Germany, explained that the increase of sugar is not due to the piling up of glucose, the most abundant of the carbohydrates in the blood, but comes from the release of glycogen, the so-called "animal sugar," which is stored in the liver. Professor Buerger demonstrated both by clinical observation and by various laboratory experiments that one of the initial effects of the injection of insulin is the release of a part of this stored carbohydrate reserve.

SYNTHETIC "milk" made out of vegetables was the means used by Dr. Ernst Tso, of Peking, to give six Chinese babies a start in life. The great scarcity of cow's milk in Oriental countries led Dr. Tso to search for a substitute. A milky liquid made of finely ground soy beans and water furnished the base for the vegetable milk. Fifty per cent. of the total calories of the diet are from this "milk." Additional foods given to the babies were cane-sugar, corn or rice starch, cod-liver oil, calcium lactate, sodium chloride and cabbage water. The last item contributed the scurvy-preventing vitamin C, present in orange juice. Six infants, one from birth and the others a few weeks old, were successfully fed six to ten months on this diet. Their weight curves follow closely the average weight curve of healthy nursing infants in the United States as well as the average weights of several hundred Chinese breast-fed infants who visited the college dispensary for minor complaints. Their mental and muscular development and nutritional status in general appear to be as good as in normal infants reared on milk diets.

WHEN we develop a fever, is the immediate cause of our discomfort to be sought in the activity of the adrenal glands? Dr. Ulf von Euler, of Stockholm, believes that these small but highly important organs, situated just above the kidneys, are the originators of fever as well as of many of the more normal functions of the body. The symptoms of fever can be produced by injecting adrenalin into the blood, and human and animal subjects with overactive adrenal glands are feverish. Tests on the stimulation of frog's and rabbit's muscle with the blood of fever patients and with adrenalin show a close parallelism in effect. Finally, it is impossible to cause fever in an animal which has lost its adrenal glands.

DR. CHI CHE WANG, Bernice Huddlestun and Irving Graef, of the University of Chicago, made two series of experiments on eight children between the ages of four and twelve years. In the first series the children received half the amount of protein or meat element in their diet that they had in the second. Metabolic studies showed that without exception the rate of growth was more than doubled during the high protein period, the average gain being 82 grams per child per day as against 29 grams for the low protein diet. These results were substantiated by similar results obtained from a study made on rats.

DR. SANFORD M. ROSENTHAL, of Washington, D. C., reports that as a result of studies upon dogs and rabbits, it was found that the rate of digestion of raw starch, as measured by the increase in blood-sugar, is markedly inhibited by acids. One cubic centimeter of 3.6 per cent. hydrochloric acid will almost completely prevent the intestinal digestion of raw starch for from one to three hours. This amount of acid does not affect the rise in blood-sugar following glucose feeding. In human beings similar findings were obtained with cooked starches. Cooked starches in man caused a rise in blood-sugar as marked as though glucose were given, but in nine normal adults 50 to 75 grams of raw starch caused no change in blood-sugar. This principle was applied to diabetics and the starch was fed as such, or as raw carrots, turnips or nuts. The increase in blood-sugar was much less than that ordinarily detected after a starch meal.

THE physiological reason for the physical and mental misery of a morphine addict when he is suddenly deprived of the drug has been sought by Doctors H. G. Barbour, B. E. Russell, S. H. Flowers, E. S. Dunham and L. G. Hunter, of Louisville. An animal to which enough mor-

NEW
MEKER FURNACE
for
Volatile Matter in Coal
Also for General Laboratory Work Using Small Crucibles

By construction this furnace enables one to run determinations of volatile matter in coal and obtain concurrent results. It is well insulated with refractories and the crucible support is so arranged that various sizes of crucibles can be used for other purposes when desired. There is an opening in the center of the removable cover through which the ventilation tube on the crucible lid extends. Complete with Meker burner and silica crucible..... **$16.00**
Extra crucibles for above..... **3.75**

PALO COMPANY
Apparatus for Industrial and Laboratory Use
153 West 23rd Street **New York, N. Y.**

THE MICROSCOPE
By SIMON H. GAGE, of Cornell University
Revised, Dark-field Edition (1927) now Available.
The Old and the New in Microscopy, with a special chapter on Dark-Field Methods and their Application.
Postpaid, $3.50
COMSTOCK PUBLISHING CO., ITHACA, N. Y.

SPLIT SECOND TIMERS
No. 1. "PASTOR." Time piece & Stop-watch, fifth second. Robust. Guaranteed. **Price $9.95 net.**
No. 3. Fifth second, 30 minute registered. Jeweled lever movement and chromium case. **Price $12.85 net.**
Write for Circular
The Sterling Stop Watch Co., Inc.
15 East 26th Street, New York City.

Hy-Speed Mixers
Clamp to any tank, operate from light circuit, mix all kinds of liquids. Also used for even temperature baths. Thousands in use.
All Sizes from 1/10 H. P.
$37.50 up
Write for circular.
ALSOP ENGINEERING CO.
47 W. 63rd St., New York

PHOTOELECTRIC CELLS
Television—Talking Pictures—Research
G.-M. VISITRON cells of the alkali metal hydride type are of highest sensitivity, low dark current, long life, and respond to the smallest changes of light intensity and color. Their high quality and uniform sensitivity make them the choice of leading engineers. Get technical Bulletin P-14 Free.
G.-M. Laboratories, Inc., 1808 Grace St., Chicago, Ill.

LaMOTTE-MORGAN
SOIL TESTING SET
This handy outfit is especially designed for rapid, accurate work in determining soil reactions. Tests can be made in from 2 to 5 minutes with an accuracy of 0.2 pH. The set covers the pH range 4.0–8.4 and this range can be extended on either end.
Complete with instructions, color chart and LaMotte Soil Handbook containing an extensive list of plants with their soil preferences.
Price $10.00 f.o.b. Baltimore.
LaMotte Chemical Products Co.
418 Light St. **Baltimore, Md., U. S. A.**

phine has been administered to make its condition comparable to that of a human addict will have the water distribution in its tissues rather notably disturbed. There is less than the normal amount of water in the interior organs, such as the liver, kidneys and brain. Conversely, there is an increase in the water content in those organs through which contact is maintained with the outside world, such as the skin, stomach and intestine. The blood also suffers an increase in water content. But when the accustomed daily doses of morphine were suddenly stopped, a remarkable redistribution of water in the body occurred. The blood, spleen and surface tissues all showed a loss, while the previously water-shy organs became edematous—that is, were gorged with water to an abnormal extent. The animals thus deprived developed trembling fits, a loss of calcium in the blood, disturbed temperature regulation and other physiological disturbances. The experimenters regard the edema of the brain —which might be roughly termed a condition of "water on the brain"—as especially significant, in that it might explain the psychological symptoms seen in morphine addicts who have been subjected to too sudden a "cure."

DR. WALTER R. MILES, of Stanford University, in a study of the effect of different drugs on the whole animal body in contrast with many recent biological experiments with drugs on separate muscles and organs, trained some laboratory rats to run through a complicated maze to reach their food. After about a month, when he thought they were perfect, he tried the effect of injecting small quantities of different drugs just before his rats were ready for a meal. Alcohol made locomotion difficult, but the rats still knew how to find their nourishment. John Barleycorn had no effect, at least in laboratory doses, on memory; but the rats couldn't walk straight. Another drug, hyoscine, a rather powerful depressant sometimes used for insomnia, produced just the opposite effect. They could walk perfectly but could not remember where to go and acted as if they were exploring the maze for the first time. No drug yet tried has been found to produce a performance which is an improvement on the normal.

THE more morphine you take the first time, the less effect a second dose is likely to have. This, in summary, is the result of the researches of Dr. Carl F. Schmidt and Dr. A. E. Livingston, of the University of Pennsylvania. The idea of building up resistance to the effects of poisons by taking small but gradually increasing doses is erroneous. Working with dogs, they found that a tolerance to morphine developed much more slowly when minute doses were given than when large quantities were administered. And when very large doses were given at the outset the resistance to subsequent doses was still more accentuated.

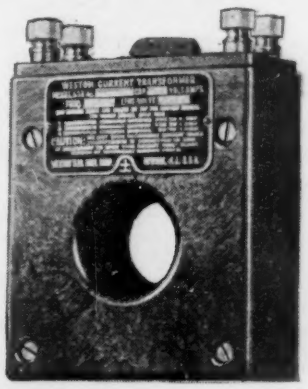
DR. DAVID I. MACHT, of the Johns Hopkins University, has experimented on the use of living plants as laboratories in which various animal poisons may be differentiated by their effects on the plants. Drugs of vegetable origin are frequently more poisonous to animals than to plants and *vice versa*. A toxin discovered by Dr. Macht in the blood of pernicious anemia patients is not present in secondary anemia and similar blood disorders. The effect of this poison on plant seedlings has furnished a convenient diagnostic test for distinguishing pernicious anemia from related blood disturbances at certain stages of its development so that curative treatment can be started earlier than would otherwise be possible. A toxin just discovered in the blood of lepers serves to differenentiate leprosy from blood sera of tuberculosis and syphilis and led to an important discovery in regard to its therapy. Further observations to be reported are on the blood of malaria, eclampsia sera, and on the extreme toxicity of certain animal poisons—of the toad, bee, ant, and, particularly, snake venoms.

MERCURY injected into the system greatly increases the sensitivity of the autonomic nervous system, the webwork of nerves that controls a large part of the functions of the internal organs. This clue to the action of one of the most dangerous classes of poisonous compounds is supplied by Dr. William Salant, of the Cold Spring Harbor Biological Station. Dr. Salant administered doses of mercury salts to anesthetized cats, and tested the nerve action with a slight electric current. The sensitivity of the nerves increased progressively with additional doses up to a certain maximum, and then fell off aagin.

THE chronic and uncontrollable rage that is characteristic of some insane patients may be due to a direct mechanical injury to a certain tract in the base of the brain. Experiments on cats pointing in this direction have been made by J. F. Fulton and F. D. Ingraham, of Oxford University. By surgical procedure under anesthesia, lesions were caused in the brain area under investigation. The cats recovered from the operation without difficulty, but they were changed cats. Gentle stroking, which before would send them into pleased purring, now evoked only signs of the most violent anger: spitting, scratching and biting. Since the structure of all mammalian brains is basically alike, the experimenters are of the opinion that their results will be of use when applied to the clinical difficulties of human beings.

THE old popular notion that blood gets "thin" when it is heated has received confirmation in the physicist's laboratory, although the heat required to make it so is a great deal more than the ordinary mortal could stand. P. Lecompte du Noüy, of Paris, has made very exact measurements of the viscosity, or "thickness" of the blood-fluid at different temperatures. Blood-serum heated progressively from a temperature of about 77 degrees Fahrenheit to one of 158 degrees reaches its lowest point of viscosity, or in every-day English becomes "thinnest," at 133 degrees, or a little more than halfway from the freezing-point to the boiling-point of water. There seems to be a physico-chemical basis for this phenomenon, for the power of the serum to change the angle of polarized light remains unaltered by heatings below that critical temperature, and then suddenly and sharply displays itself.

For Measuring A. C. Currents



from 0.2 to 200 Amperes

The Model 539

Miniature Portable Current Transformer

—and the

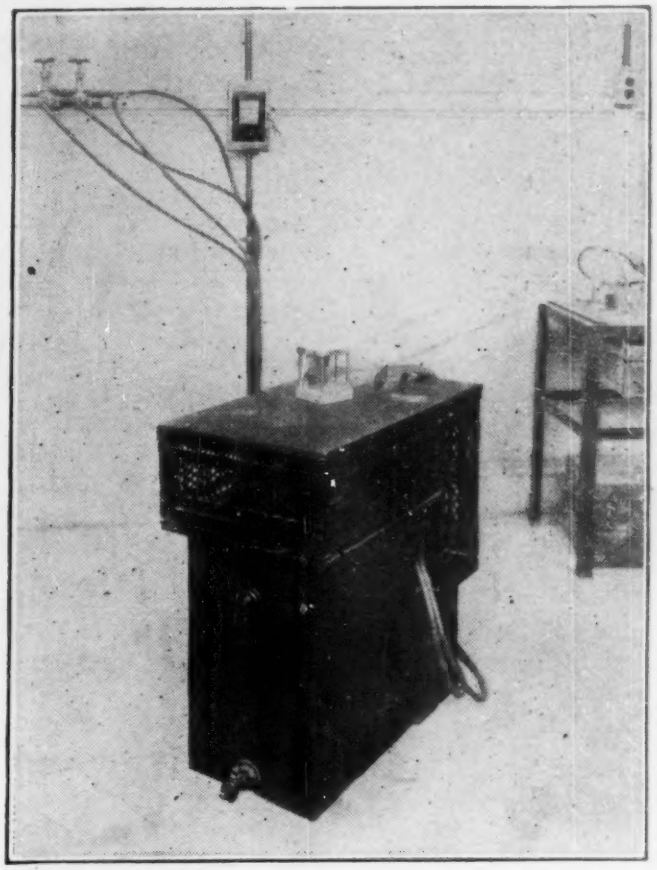
Model 528

A. C. Ammeter

Here is the ideal combination for use in industry, laboratories, field work and educational institutions wherever portability and lightness are essential and low cost is important. The Model 539 Transformer weighs only 2⅝ lbs. and has self-contained primary ranges of 2–5–10–20 amperes with inserted primary ranges of 50–100–200 amperes—and a miniature A. C. Ammeter, Model 528, having a full scale reading of one ampere. The self-contained primary ranges are changed by an unique range-changing switch. The transformer has a guaranteed accuracy of 1% of frequencies of 25 to 150 cycles. Speed and ease of operation are the outstanding characteristics of these companion instruments.

WESTON ELECTRICAL INSTRUMENT CORP.
585 Frelinghuysen Ave. Newark, N. J.

Weston
PIONEERS SINCE 1888
INSTRUMENTS



3 kv-a. Converter with Furnace on top.

AJAX-NORTHRUP FURNACES

are built in sizes from 1 Ounce to 1 TON

Our customers are reporting BETTER METALS cast from their AJAX-NORTHRUP Furnaces.

The little 3 kv-a. which costs only $650, will make up to ten ounce melts of steel. It reproduces the same ideal melting conditions that exist in the large production sizes.

Write for information!

Ajax Electrothermic Corporation
Trenton, New Jersey

G. H. CLAMER, *Pres. & Gen. Mgr.*

E. F. NORTHRUP, *V. Pres. & Tech. Adv.*

AJAX NORTHRUP
ELECTRIC FURNACES

ZEISS

Physicians' and Laboratory Microscope

E S C-106

Magnifications 56-900x

Fixed stage, 12 cm. square
Illuminating apparatus with rack and pinion
Condenser 1.2 with iris
Triple revolving nosepiece
Fine adjustment with graduated drum

Achromatic objectives:
8 n.a. 0.20
40 n.a. 0.65
90 n.a. 1.25 oil imm.
Huygens oculars 7x and 10x

Price, $128.00 f. o. b. N. Y.

A good dark field outfit is obtained by adding: Cardioid condenser $22, extra for iris for oil im. $4. Compensating ocular 15x: $8.50.

CARL ZEISS, INC.

485 Fifth Ave., New York

Pacific Coast Branch, 728 South Hill Street, Los Angeles, Calif.

CARL ZEISS
JENA